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THE PHILIPPINE AGRICULTURIST

UNIVERSITY OF THE PHILIPPINES PUBLICATIONS SERIES A

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Published by
THE COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
UNIVERSITY OF THE PHILIPPINES

The Philippine Agriculturist

(University of the Philippines Publications Series A)

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THE PHILIPPINE AGRICULTURIST is published monthly, except in April and May, beginning with Volume 35, by the College of Agriculture and Central Experiment Station, University of the Philippines, Los Baños, Laguna. The subscription price is ₱6.00 a year in the Philippines and $4.00 (U.S. currency) elsewhere; the price of single copies, ₱0.75 in the Philippines and $0.50 (U.S. currency) elsewhere.

Business correspondence should be addressed to the Business Manager, THE PHILIPPINE AGRICULTURIST, College, Laguna, Philippines. All remittances should be made payable to THE PHILIPPINE AGRICULTURIST.

Communications for the editor should be addressed to the Editor, THE PHILIPPINE AGRICULTURIST, College, Laguna, Philippines.

Publications sent in exchange for THE PHILIPPINE AGRICULTURIST should be addressed: Library, College of Agriculture and Central Experiment Station, College, Laguna, Philippines.

Entered at the Post Office at College, Laguna, Philippines, as second-class mail matter.

THE EXPENDITURE OF INCOMES OF RURAL FAMILIES IN DAYAP, CALAUAN, LAGUNA [1]

LOLITA C. RIVERA

Farm families spent more than nonfarm families in all income classes. A total income of ₱1,735 for farm families and ₱1,304 for nonfarm families was available for disposal. For actual family living, the farmers spent slightly less than the nonfarmers. The outlay for food constituted almost one-half of the total receipts for both groups of families. Expenditures for all family living items increased with increases in income. For food, clothing, and some other items, the increase was not proportionate to the increase in income. Recreational, educational, and personal expenses tended to be more in absolute and percentage terms as the income level rose. This was true for farm and nonfarm families.

A better understanding of how rural families allocate their expenditures and how much they spend during a given period will help in finding ways of aiding rural consumers to obtain the greatest possible satisfaction from their limited means. This is important because the level of family living depends upon the amount of income and how wisely it is spent.

Ernst Engels laid down the following laws after an intensive study on the standard of living:[2]

(1) The greater the income, the smaller the relative percentage outlay for subsistence.

(2) The percentage outlay for clothing is approximately the same, whatever the income is.

(3) The percentage for lodging or rent, and for fuel and light, is invariably the same whatever the income is.

(4) As income increases in amount, the percentage of outlay for sundries becomes greater.

According to Zimmerman and Black,[3] spendable incomes of urban wage- and salary-earning families increase faster than expen-

[1] Central Experiment Station Contribution No. 1847. Taken from a thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1955. Prepared in the Department of Agricultural Economics under the direction of Visiting Professor Chase Del-Mar Kearl.

[2] J. H. Dodd, "Applied Economics," Southeastern Publishing Co., Cincinnati, Ohio, 1945, p. 41.

[3] C. C. Zimmerman and J. D. Black, *Minnesota Agric. Exper. Sta. Bull.*, 246, (1928).

ditures for physiological necessities and slower than those for luxury. For farm families, the spendable income increases much faster than either type of expenditures.

Hunter and Bottom [4] stated that farm-produced food accounted for over one-third of the total value of all food consumed by farm families in each income bracket.

THE STUDY

Data on expenditure of 100 family incomes were obtained by interviews with each family in Dayap, a thickly populated barrio of Calauan, a second-class municipality in the province of Laguna. Dayap has about 778 residents, the majority of whom are engaged in farming. A highway and a railroad pass through the area. It has only one primary school; children have to go to the town to continue schooling. Rice and coconuts are the two primary products. Sugar cane is secondary.

FAMILY ECONOMIC SITUATION

The average farm family income exceeded the nonfarm family income in the area studied. Eleven per cent of the farm families belonged to the top income class of ₱3,500 and over; there were no nonfarm families in that bracket (table 1).

TABLE 1.—*Number of farm and nonfarm families by income class, 100 families, Dayap, Calauan, Laguna, 1954*

INCOME CLASS	FARM		NONFARM	
	Number	Per cent	Number	Per cent
Below ₱1000	14	23	13	34
₱1000–₱1499	16	26	13	33
₱1500–₱3499	24	40	13	33
₱3500 and over	7	11	—	—
Total	61	100	39	100

AGE OF HEAD OF FAMILY AND INCOME

The ages of heads of farm and nonfarm families ranged from 28 to 80 years. The average for the farmers was 42 years. For nonfarmers, it was 40 years (table 2).

There was no relationship between income and age. Farmers making high and low incomes were relatively young.

[4] S. M. Hunter and J. C. Bottom, *Indiana Agric. Sta. Bull.*, 588 (1953).

TABLE 2.—*Average age of family heads*

INCOME CLASS	FARM	NONFARM
Below ₱1000	48	39
₱1000–₱1499	40	37
₱1500–₱3499	43	41
₱3500 and over	42	—
Average	42	40

SIZE OF HOUSEHOLD AND INCOME

Nonfarm families had an average of 5.9 members. This number included parents, children, and others residing in the household (table 3).

TABLE 3.—*Average number of children and adults per family*

INCOME CLASS	Children			Adults	Total
	Below 7 years	7-8 years	9 and over		
FARM					
Below ₱1000	2.0	—	1.7	2.1	5.8
₱1000–₱1499	2.8	1.0	1.0	3.2	8.0
₱1500–₱3499	3.0	1.0	—	7.5	11.5
₱3500 and over	—	2.0	3.6	3.9	9.5
Average					6.3
NONFARM					
Below ₱1000	—	1.8	1.7	2.0	5.5
₱1000–₱1499	2.0	2.0	1.0	1.8	6.8
₱1500–₱3499	3.8	1.5	1.2	3.5	10.0
₱3500 and over	—	—	—	—	—
Average					5.9

Farm families tended to be larger than nonfarm families; the average size was 6.3 members. This may be explained by the fact that farm families need children and other persons for farm labor.

As income increased, the number of children, as well as of adults, tended to increase for both farm and nonfarm families. The high-income farm families, however, were not quite as large as the medium-income families.

EDUCATIONAL ATTAINMENT AND INCOME

Farm family heads had slightly less formal schooling than nonfarm family heads. The average number of years spent in school was 4.9 for farm family heads and 5.2 for nonfarm family heads.

Income was directly related to education of both farm and nonfarm family heads (table 4). As income increased, educational attainment also increased.

TABLE 4.—*Educational atttainment of head of family*

INCOME CLASS	AVERAGE NUMBER OF YEARS SPENT IN SCHOOL	
	Farm	Nonfarm
Below ₱1000	1.2	2.6
₱1000–₱1499	3.3	3.5
₱1500–₱3499	4.2	5.6
₱3500 and over	5.1	—
Average	4.9	5.2

Heads of nonfarm families had a slightly higher level of education. Consistently, the farmers making the same levels of income as the nonfarmers were less educated.

SIZE OF FARM AND INCOME

The number of hectares operated was an important factor in determining farm family income: the income increased with an increase in the number of hectares operated (table 5).

TABLE 5.—*Average number of hectares operated*

INCOME CLASS	HECTARES
Below ₱1000	1.3
₱1000–₱1499	2.2
₱1500–₱3499	3.3
₱3500 and over	12.1
Average	4.6

DISPOSABLE INCOME

Common sources of income among farm families were sales from crops, livestock and livestock products, and other farm products.

Nonfarm family workers usually worked either as laborers or as office employees.

The average disposable income (cash and noncash income minus farm expenses) of farm families amounted to ₱1,735. This was supplemented by income in kind or farm and home-furnished supplies valued at ₱397. On the other hand, the disposable income of nonfarm families averaged ₱1,304 and was supplemented by income in kind amounting to ₱196 (table 6).

TABLE 6.—*Disposable income and income in kind*

INCOME CLASS	FARM				
	Disposable income		Income in kind		Total
	Amount	Percentage of total	Amount	Percentage of total	
Below ₱1000	₱ 623	70	₱261	30	₱ 884
₱1000–₱1499	1268	77	377	23	1645
₱1500–₱3499	1755	82	390	18	2145
₱3500 and over	6982	93	544	7	7526
Average	₱1735	81	₱397	19	₱2132
	NONFARM				
Below ₱1000	₱ 617	73	₱229	27	₱ 846
₱1000–₱1499	1217	89	151	11	1368
₱1500–₱3499	2198	95	121	5	2319
₱3500 and over	—	—	—	—	—
Average	₱1304	87	₱196	13	₱1500

As total income increased, income in kind tended to be a smaller proportion of the total. For farm families it increased in absolute terms as income increased. For nonfarm families it decreased both in percentage and in absolute amount.

EXPENDITURES

Farm families spent an average of ₱1,572 for goods and services for family living and farming operation. Nonfarm families spent ₱1,546 (table 7).

Farm expenses made up a relatively small part of the total expenditures, averaging only 16 per cent for farm families and 3 per cent for nonfarm families. Most of the other expenses of both groups were for food and clothing and other family living items.

TABLE 7.—*Distribution of expenditures for farm operation and family living*

ITEM OF EXPENSE	FARM		NONFARM	
	Amount	Per cent	Amount	Per cent
Farm expenses	₱ 246	16	₱ 50	3
Food	581	37	707	46
Farm-furnished supplies	30	2	26	2
Household operation	116	7	82	5
Clothing and footwear	138	9	114	7
Medical care	66	4	52	3
Education and recreation	140	9	120	8
Personal	106	7	119	8
Miscellaneous	149	9	276	18
Total average	₱1572	100	₱1546	100

Different authors who have studied family expenditures agree that food generally constitutes the highest percentage of all family expenses (table 8). Clothing is next. In the study made by the Bureau of Labor, miscellaneous items rank second.

TABLE 8.—*Comparison of expenditures findings*

ITEM OF EXPENSE	KIRKPATRICK, (1926)[a]	KIRKPATRICK, ATUATOR, AND BAILEY (1924)[b]	BUREAU OF LABOR (1926)[c]	THIS STUDY (1955)[d]	
				Farm	Nonfarm
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Food	14.7	39.5	29	37	46
Clothing	14.2	13.9	7	9	7
Rent	12.5	16.6	11	—	—
Fuel and light	—	—	6	7	5
Education	6.6	—	5	9	8
Operation expenses	5.3	6.2	—	—	—
Health	3.8	4.1	—	4	3
Personal	—	1.2	—	7	8
Life insurance	2.6	—	—	—	—
Miscellaneous	—	0.6	12	9	18

[a] E. L. Kirkpatrick, *USDA Farmer's Bull.* (1926).
[b] E. L. Kirkpatrick, H. W. Atuator, and I. M. Bailey, *USDA Farmer's Bull.*, 1214 (1924).
[c] A. Agbanlog, *Philippine Agriculturist*, 18, 581 (1930).
[d] Amount available for family living is total expenditures plus farm-furnished food and supplies less expenditures for farming operations.

The average expenditure for family living, including farm-furnished food and supplies, was ₱1,572 for farm families and ₱1,546 for nonfarm families. The percentage for the families in this study

followed the pattern of other studies, except that a greater proportion was spent for food and, consequently, less for other items.

It should be noted that although the income of farm families was considerably higher than that of nonfarm families, the total expenditures were only slightly higher. Presumably the difference went into savings. This is the usual pattern when comparing farm and nonfarm families. Forced saving is one of the ways by which farm families get ahead. It should further be noted that family expenditures were less for farm than for nonfarm families even though the incomes were much higher.

RELATION OF EXPENDITURES TO TOTAL INCOME

Food expenses constituted almost half of the average total expenditures for both farm and nonfarm families. As farm income increased, there was a tendency for the percentage outlay for food to decrease in both family groups. At the same time, the total amount spent for food increased with the income.

The percentage outlay for clothing was approximately the same in all income classes of both farm and nonfarm families. In absolute terms the amount spent increased as income increased.

Educational and recreational expenditures tended to increase percentagewise for both family groups, except in the farmer high-income class where the percentage dropped to 3.

Personal expenditures increased as income increased for farm and nonfarm families (table 9).

INCOME AVAILABLE FOR FAMILY LIVING

Expenditures for food. The percentage outlay for food was almost one-half of the total available for family living,[5] but it decreased proportionally with an increase in income level. This held true for both farm and nonfarm families (table 10). The total amount spent for food increased with the increasing incomes of each group. These findings agree with Engel's.

Expenditures for clothing and footwear. Clothing was second to food in importance for both farm and nonfarm families. Unlike Engel's findings, clothing expenditures increased as family incomes increased, but the proportion of the total tended to decrease (table 11). This was true for farm and nonfarm families.

[5] Total disposable income minus farm expenses.

TABLE 9.—*Average expenditures per family*

ITEM OF EXPENSE	INCOME CLASS Below ₱1000		₱1000-1499		₱1500-3499		₱3500 and over	
	Amount	Per cent	Amount	Per cent	Amount	Per cent	Amount	Per cent
Farm:								
Farm expenses	₱ 31	6	₱ 146	12	₱ 116	9	₱ 506	15
Food	309	56	621	53	660	49	1434	42
Household expenses	43	8	98	8	103	8	312	9
Clothing and footwear	93	17	134	11	136	10	325	9
Medical care	25	5	62	5	58	4	111	3
Education & recreation	27	5	99	9	123	9	119	3
Personal	19	3	29	2	110	8	492	14
Miscellaneous	—	—	—	—	37	3	156	5
Total	₱547	100	₱1189	100	₱1343	100	₱3455	100
Nonfarm:								
Garden expenses	19	3	64	5	132	7	—	—
Food	411	68	837	65	959	50	—	—
Household expenses	36	6	41	3	62	3	—	—
Clothing and footwear	68	11	150	12	175	9	—	—
Medical care	23	4	44	3	95	5	—	—
Education & recreation	27	5	60	5	154	8	—	—
Personal	18	3	88	7	173	9	—	—
Miscellaneous	—	—	—	—	176	9	—	—
Total	₱602	100	₱1284	100	₱1926	100	—	—

TABLE 10.—*Expenditures per family for food*

INCOME CLASS	FARM		NONFARM	
	Amount spent	Percentage of income available for family living	Amount spent	Percentage of income available for family living
Below ₱1000	₱ 309	50	₱411	69
₱1000–₱1499	621	49	837	67
₱1500–₱3499	660	38	959	44
₱3500 and over	1434	21	—	—

TABLE 11.—*Expenditures per family for clothing*

INCOME CLASS	FARM		NONFARM	
	Amount spent	Percentage of income available for family living	Amount spent	Percentage of income available for family living
Below ₱1000	₱ 93	15	₱ 68	11
₱1000–₱1499	134	11	64	5
₱1500–₱3499	136	8	175	8
₱3500 and over	325	5	—	—

Expenditures for education and recreation. Since "education and recreation" was considered a luxury rather than a necessity by both groups, its percentage outlay relative to income available for family living was small (table 12). For nonfarm families, increase in income was directly associated with an increase in the percentage outlay for this item. It did not change with changes in income level for farm families.

Expenses for education included allowances for children, matriculation and tuition fees, school contributions, payments for books and other school supplies, and subscriptions to foreign and local magazines. Recreation expenses included those for transportation, shows, dances, and other activities for self-enjoyment.

TABLE 12.—*Expenditures per family for education and recreation*

INCOME CLASS	FARM		NONFARM	
	Amount spent	Percentage of income available for family living	Amount spent	Percentage of income available for family living
Below ₱1000	₱ 27	4	₱ 27	4
₱1000–₱1499	99	8	60	5
₱1500–₱3499	123	7	154	7
₱3500 and over	119	2	—	—

Expenditures for health and medical care. Neither farm nor nonfarm families spent much for the prevention of illness and such things as physical checkups. The expenditures for this item were mostly limited to maternity expenses of farm and nonfarm wives and to dental expenses of individuals in the households (table 13). As income increased, there was an increase in the total outlay for health and medical care. Among the farm families, the proportion decreased with an increase in income; among the nonfarm families, it remained the same.

TABLE 13.—*Expenditures per family for health and medical care*

INCOME CLASS	FARM		NONFARM	
	Amount spent	Percentage of income available for family living	Amount spent	Percentage of income available for family living
Below ₱1000	₱ 25	4	₱23	4
₱1000–₱1499	62	5	44	4
₱1500–₱3499	58	3	55	4
₱3500 and over	111	2	—	—

Personal expenditures. For farm and nonfarm families, personal expenses increased both in total amount and in percentage with the amount of income received (table 14). People with low incomes cannot afford to spend much on personal items.

TABLE 14.—*Expenditures per family for personal items*

INCOME CLASS	FARM		NONFARM	
	Amount spent	Percentage of income available for family living	Amount spent	Percentage of income available for family living
Below ₱1000	₱ 19	3	₱ 18	3
₱1000–₱1499	29	2	88	7
₱1500–₱3499	110	6	173	8
₱3500 and over	492	7	—	—

SOCIOLOGICAL CONDITIONS AND INCOME

Types of dwellings. The houses of most of the families studied were classified as fair. They were mostly of native materials, as nipa for roofs, bamboo for floors, and either wood or nipa for walls. Only 7 of the 30 nonfarm families and 8 of the 61 farm families had dwellings considered good; that is, the houses had galvanized iron roofs and wooden floors and walls and were large enough for the family members. Houses not falling under the types mentioned were considered poor (table 15).

TABLE 15.—*Types of dwellings*

INCOME CLASS	FARM			NONFARM		
	Poor	Fair	Good	Poor	Fair	Good
Below ₱1000	8	6	—	7	6	—
₱1000–₱1499	2	12	2	—	10	3
₱1500–₱3499	—	20	4	—	9	4
₱3500 and over	—	5	2	—	—	—

There was a definite tendency for farm and nonfarm families with higher incomes to have better houses. The low-income classes had poor or fair houses. High-income classes had fair or good houses.

Household conveniences. For both groups of families, household facilities for family convenience increased with the income. For all income classes in both groups, 100 per cent had flatirons (table 16). Costly and scarce items such as radios and kerosene stoves increased in number as the incomes increased.

TABLE 16.—*Percentage of families having household conveniences*

CONVENIENCES	INCOME CLASS			
	Below ₱1000	₱1000-1499	₱1500-3499	₱3500 & over
Farm:				
Sewing machine	—	—	25	29
Wooden benches	28	62	46	43
Kerosene stove	—	—	13	71
Flatiron (native)	100	100	100	100
Wooden chairs	43	100	100	100
Bamboo bed	—	—	25	—
Dining table	—	50	100	100
Radio	—	6	13	29
Nonfarm:				
Sewing machine	—	31	8	—
Wooden benches	62	69	31	—
Kerosene stove	—	23	38	—
Flatiron (native)	62	100	100	—
Wooden chairs	31	100	100	—
Bamboo bed	—	—	15	—
Dining table	15	92	100	—
Radio	—	8	100	—

Loans. Almost 90 per cent of all farm and nonfarm families borrowed either cash or commodities. Low-income families of both groups seemed to tend more to report borrowing than families with higher incomes (table 17). However, the evidence is far from conclusive. The money loans were used for household maintenance, farm expenses, or health and medical supplies. Sources of loans were landlords, relatives, friends, and nearby stores.

TABLE 17.—*Percentage of families that borrowed money*

INCOME CLASS	Farm	Nonfarm
Below ₱1000	100	100
₱1000–₱1499	87	100
₱1500–₱3499	96	77
₱3500 and over	100	—

Recreational activities. Chatting, going to moving pictures, cockfighting, and gambling were some of the most common recreational activities (table 18). The proportion of heads of households who engaged in these activities increased as the income increased. This was especially true for the more expensive activities such as going to moving pictures and engaging in sports. Chatting, which was

most common for those with low incomes, lessened as the income went up.

TABLE 18.—*Percentage of family heads engaged in common recreational activities*

KIND OF RECREATION	INCOME CLASS			
	Below ₱1000	₱1000-1499	₱1500-3499	₱3500 & over
Farm:				
Cockfighting	57	57	58	71
Moving pictures	14	63	83	100
Sports	36	19	79	43
Gambling	50	50	75	29
Chatting	100	87	87	57
Nonfarm:				
Cockfighting	69	46	92	—
Moving pictures	31	38	100	—
Sports	23	62	69	—
Gambling	62	85	62	—
Chatting	100	77	92	—

Membership in organizations. Most of the families belonged to the Parent-Teachers Association. The proportion of membership increased markedly as income increased. Among the farm families with income levels of ₱3,500 and over, 100 per cent belonged to the PTA (table 19). Sixty-four per cent of the farm families with incomes below ₱1,000 did not belong to any association. Among nonfarm families, a higher percentage generally belonged to the PTA.

There were no farm family heads who belonged to labor organizations. Among nonfarm family heads, the proportion was relatively small and increased with income.

TABLE 19.—*Percentage of family head membership in organizations*

INCOME CLASS	FARM			NONFARM		
	PTA	Labor organization	None	PTA	Labor organization	None
Below ₱1000	36	—	64	72	—	23
₱1000–₱1499	63	—	37	85	8	7
₱1500–₱3499	83	—	17	85	15	—
₱3500 and over	100	—	—	—	—	—

THE MIMOSINE CONTENT OF LOCALLY GROWN IPIL-IPIL (LEUCAENA GLAUCA)[1]

APOLINARIO R. CARAÑGAL, JR. AND ALICIA D. CATINDIG

WITH TWO TEXT FIGURES

Mimosine may be detected in the amino acid chromatogram by using iron salts and ninhydrin as spray indicators. Quantitative determination by paper chromatographic analysis is suggested.

Leaves of the local variety of ipil-ipil contain more mimosine than the Hawaiian variety. Mature leaves and pods have less mimosine than the young ones.

Higher temperature and longer extraction time favor the extraction of mimosine with water from fresh leaves of ipil-ipil. A method of batch extraction with water which is applicable on the farm was developed.

Ipil-ipil (*Leucaena glauca* Linn.) is a leguminous plant found throughout tropical America. In the Hawaiian Islands it is commonly called koa haole and is used as an excellent source of crude protein for animal feed. To some extent ipil-ipil seed and leaf meals have been tested locally as supplements of fish meal in poultry rations (Pizzaro, 1947; Baclig and Fronda, 1949; Fronda and Dingayan, 1950; Burgos and Martin, 1950; Corpuz, 1951).[2]

The use of ipil-ipil as feed for nonruminants has been limited by the presence of mimosine. Mimosine, when ingested, causes reduction in growth, alopecia, and general ill-health. It is an amino acid with the structural formula β [N-(hydroxy pyridene - 4)] α - amino propionic acid.[3] It is identical with leucaenol or leucaenine.[4] Matsumoto and Sherman have devised a rapid method of analyzing for mimosine.[5]

Ipil-ipil can only be used liberally in poultry and pig rations if the mimosine content is reduced or its toxicity inhibited. Matsumoto, Smith, and Sherman found $FeSO_4$ to reduce mimosine toxicity

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[1] Central Experiment Station Contribution No. 1848. Report of Research Project No. 676.

[2] Cited in Feed Manufacturers' Conference Proceedings, UP College of Agriculture and Central Experiment Station, March 12, 1955.

[3] J. P. Wibaut, *Helv. Chim, Acta,* 29, 1669 (1949).

[4] J. P. Wibaut and R. J. C. Kleipool, *Rev. Trav. Chim,* 69, 37 (1950).

[5] H. Matsumoto and G. D. Sherman, *Arch. Biochem. and Biophysics,* 33, 195 (1951).

for rats.[6] In the present work relative determinations of the mimosine contents of the leaves and whole pods of ipil-ipil were made to find out the factors that affect the level of the acid in the plant. In addition, the behavior of mimosine in chromatographic analysis and water treatment of the meals was studied.

EXPERIMENTAL PROCEDURE

Alcoholic (70 per cent ethyl alcohol) extracts and acid hydrolyzates of the leaf and seed meals of ipil-ipil were prepared. The concentrated solutions were chromatographed on paper with phenol-H_2O (first solvent) and n-butyl alcohol-acetic acid-water by the ascending technique. The position of mimosine in the chromatogram was revealed by comparing two-dimensional chromatograms separately sprayed with $FeCl_3$, $FeSO_4$, and ninhydrin. The spot which gave color reactions to these reagents was mimosine.

The mimosine contents in all the subsequent experiments were determined according to the method of Matsumoto and Sherman.[7] The spectrophotometric readings at 535 mμ (optical density) were measured in the Coleman spectrophotometer. Only relative determinations were made because pure mimosine was not obtainable. A standard curve prepared by diluting concentrated water-extract of ipil-ipil was used as the basis for comparison.

Freshly gathered leaves of the local and Hawaiian varieties of ipil-ipil were immediately analyzed for mimosine. The effect of maturity on the leaves was minimized by taking representative 10-gram samples from a large amount of sample.

The effect of stage of maturity on the mimosine content of fresh leaves and whole pods of the local variety of ipil-ipil was determined. Pods from a tree were classified into six stages of maturity based on seed development. The pods in the first or youngest stage to the fifth stage were still green; those in the sixth stage were brown and dried. The pods were dried to constant weight in the forced-draft oven (80°C.) and ground in the Wiley mill. Four 0.5-gram samples from each stage of maturity were analyzed for mimosine.

Since mimosine is water-soluble it may be extracted with water. The batch extraction of mimosine from the leaves with water at dif-

[6] H. Matsumoto, E. G. Smith, and G. D. Sherman, *Arch. Biochem. and Biophysics*, 33, 201 (1951).

[7] Matsumoto and Sherman, *op. cit.*

ferent temperatures and lengths of time was studied. The initial amount of mimosine for each set of experiments was determined. Ten-gram samples were extracted with 100 ml. of water for 30, 60, and 120 minutes at 40°C., 65°C., and 85°C. and for shorter times at 100°C. The amount of mimosine in the water extracts was determined. The percentage of extraction was based on the initial amount of mimosine.

Batch extraction at 100°C. for 5 minutes was further studied. The mimosine content was determined at the start and after each extraction.

DISCUSSION OF RESULTS

Chromatographic analysis. The position of mimosine on the two-dimensional chromatogram was revealed by the color developed with ninhydrin and iron salts. The mimosine spot may be cut out and determined quantitatively by the method of Matsumoto and Sherman without clarification with carbon.

Mimosine content of leaves. The local variety seemed to have about 1.19 times more mimosine than the Hawaiian variety in the leaves (table 1). On the basis of the mimosine content of the Hawaiian variety as reported from abroad, the leaves of the local variety contained 4.4 to 7.5 per cent mimosine, dry weight.

TABLE 1.—*Spectrophotometric readings of the mimosine content of the leaves of local and Hawaiian ipil-ipil*

VARIETY	OPTICAL DENSITY				
	I	II	III	IV	Average
Local	0.53	0.63	0.52	0.55	0.56
Hawaiian	0.43	0.48	0.53	0.46	0.45

Effect of stage of maturity. The young leaves had 2.3 times as much mimosine as the mature leaves (table 2). On the dry-weight basis this value is possibly higher since the young leaves have a higher moisture content than the mature leaves. The young leaves, how-

TABLE 2.—*Effect of stage of maturity of the leaves*

LEAF SAMPLES	OPTICAL DENSITY				
	I	II	III	IV	Average
Young	0.52	0.41	0.51	0.43	0.46
Mature	0.22	0.20	0.23	0.19	0.21

ever, represent only a small part of the leaves used in the preparation of the meal.

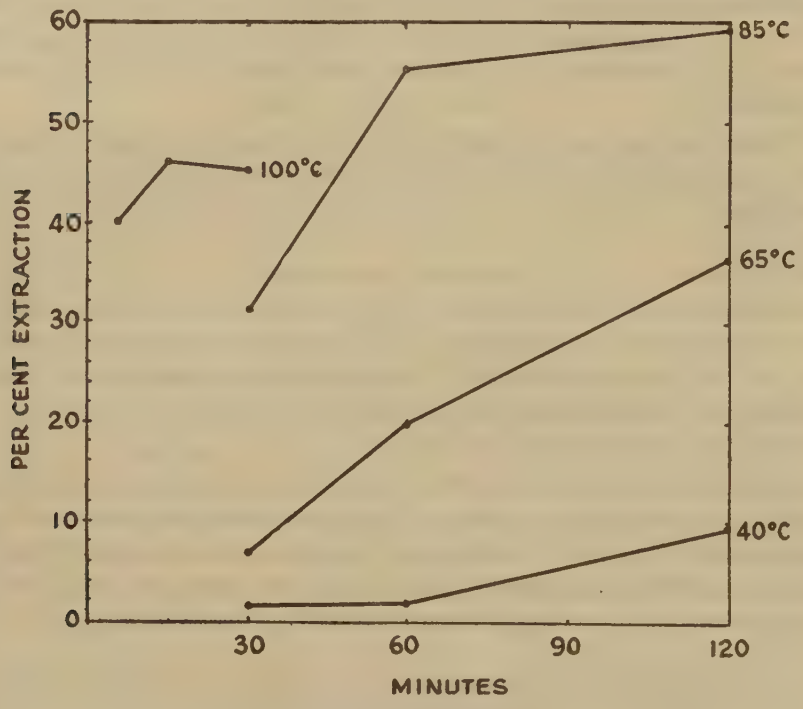

Fig. 1.—Effect of temperature and length of time on water extraction of mimosine from the leaves of ipil-ipil.

As with the leaves, the pods decreased in mimosine content with maturity (table 3).

TABLE 3.—*Effect of stage of maturity of pods*

STAGE OF MATURITY	OPTICAL DENSITY				RELATIVE AMOUNT OF MIMOSINE [a]
	I	II	III	IV	
1st [b]	0.72	0.65	0.77	0.71	3.75
2nd	0.64	0.62	0.62	0.63	3.36
3rd	0.48	0.58	0.50	0.52	2.75
4th	0.35	0.35	0.36	0.35	1.91
5th	0.29	0.32	0.29	0.30	1.62
6th	0.20	0.18	0.19	0.19	1.00

[a] Based on the amount of mimosine in the oldest or 6th stage as 1.00.
[b] The youngest stage.

Meals may be prepared from whole pods rather than from the seeds alone. However, the amount of protein and, possibly, of crude fiber must be considered. Although the dried mature pods have the least mimosine, they may not be as palatable as the green pods and may differ in protein and crude fiber contents. This will be the subject of further investigation.

Extraction of mimosine from fresh leaves with water. After extraction with water at high temperatures, the leaves lost some of their color but were not destroyed. After two hours at 85°C., about

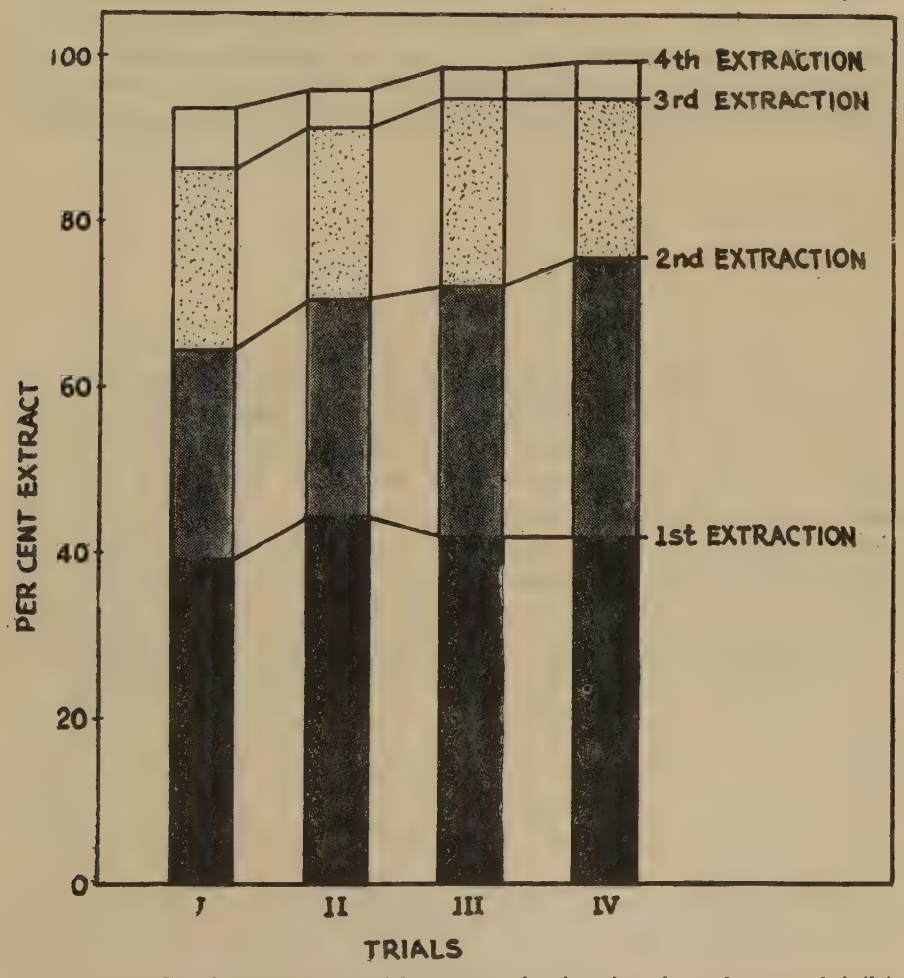

Fig. 2.—Batch extraction with water of mimosine from leaves of ipil-ipil.

60 per cent of the original mimosine was extracted. Thirty-eight per cent was extracted at 65°C., and 10 per cent at 40°C. (fig. 1). After 5 minutes, 40 per cent was extracted at 100°C. The amount tended to level off to 45 per cent at 15 to 30 minutes. Higher temperature and longer extraction time favor the extraction of mimosine with water. Such conditions, on the other hand, may lower the protein content of the leaves.

Batch extraction of the leaves at 100°C. for 5 minutes was found effective. After the fourth extraction almost all the mimosine was extracted (fig. 2). However, this method may be so drastic as to lower the protein content. Further studies are being made to determine the change in the protein content during these conditions of extraction. This method of lowering the mimosine content is applicable on the farm, unlike the method of Matsumoto and Sherman which involves storage at elevated temperature and steam distillation.

. . . the scientist analyzes where the artist interprets, the scientist seeks elements where the artist aims at the meaning, the scientist works towards laws where the artist seeks values, the scientist explains where the artist appreciates; but both, that must be clear, aim to give us an understanding of the objective world, both give us truths. Both are, on the other hand, more than mere passive mirrors of the world; both come with subjective energies towards the world, as the scientific account with its aiming at connection involves just as many subjective activities as the artistic rendering with its aim towards isolation of the special thing.—*Hugo Münsterberg*

ERYTHROCYTE AND LEUCOCYTE COUNTS AND HEMOGLOBIN INDEX OF THE BLOOD OF BROWN SWISS COWS [1]

ANTONIO MA. A. LAZARO

The mean hemoglobin index of six Brown Swiss cows was 8.81 grams per 100 ml. of blood. Significant variations of the hemoglobin indices were found between animals and between months. The correlation coefficients between hemoglobin index and rainfall, atmospheric temperature, and relative humidity were negative and insignificant.

The average leucocyte count was 11.375 thousand per ml. of blood. Leucocyte count and the three climatic factors were not significantly correlated. Monthly variations in leucocyte counts were significant.

The mean number of erythrocytes per ml. of blood was 4.761 million. Significant monthly variations were found in the erythrocyte counts of the six cows. The correlation coefficient between erythrocyte count and relative humidity was suggestive at the 5 per cent probability level. The mean corpuscular hemoglobin index was 18.50 micro micrograms.

This study to determine the hemoglobin index and leucocyte and erythrocyte counts of the Brown Swiss breed of dairy cattle, newly introduced in the Philippines, was conducted in the Department of Animal Husbandry from July, 1953, to June, 1954.

MATERIALS AND METHODS

Six apparently healthy Brown Swiss dairy cows which arrived from California in May, 1953, were used in this experiment. The ages of the animals were as follows: No. 89, 90, 93, 96—3 years; No. 94 and 97—2 years, 10 months. All the cows were given the same feed, care, and management throughout the experiment.

The blood samples for the determination of the hemoglobin index and blood cell counts were drawn from one of the jugular veins of each animal on the second and fourth weeks of every month between 8:00 a.m. and 12:00 n. They were then placed in vials containing an anticoagulant consisting of four parts of potassium oxa-

[1] Central Experiment Station Contribution No. 1849. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1954. Prepared in the Department of Animal Husbandry under the direction of Dr. Gonzalo V. Garcia.

late and six parts of ammonium oxalate dissolved in 90 parts distilled water, all parts by weight.

The hemoglobin indices were determined by the Haden-Hausser hemoglobinometer. A white pipette and 1/10 normal hydrochloric acid diluting fluid were used in the analyses. In the leucocyte and erythrocyte counts, a microscope with a mechanical stage, hemacytometer, and hand tally counter were used. The leucocyte counts and hemoglobin indices were determined from the contents of one pipette. The technique used for the erythrocyte enumeration was similar to that for the leucocyte enumeration except that the red pipette and Hayem's solution were used.

The data on rainfall, atmospheric temperature, and relative humidity in Los Baños, Laguna, during the experiment were obtained from the Department of Agricultural Engineering. January to April was taken as the dry season, and May to December, as the wet season.

DISCUSSION OF RESULTS

Hemoglobin content. The main hemoglobin index of the six Brown Swiss cows was 8.81 grams per 100 ml. of blood. This is markedly lower than the mean value of 10.96 reported by Brookes and Hughes [2] in 335 determinations on 297 head of Jersey, Guernsey, and Holstein dairy cattle and the value of 10.05 grams per 100 ml. of blood for Red Sindhi cattle reported by Gajardo.[3]

Cow No. 93 had the lowest hemoglobin value of 7.96 grams per 100 ml., and cow No. 94 registered the highest mean value of 9.69 grams (table 1). The monthly hemoglobin indices of the six Brown Swiss cows varied significantly at the 5 per cent probability level. The animals varied significantly from each other also at the 5 per cent level.

The hemoglobin indices of the Brown Swiss cows rose from 9.04 in January to 9.75 in February and then dropped to 8.88 in April. The mean hemoglobin index for the dry season was 9.12 grams per 100 ml. of blood. During the wet season, the hemoglobin indices varied slightly from 8.67 to 8.46 grams per 100 ml. of blood; the mean content was 8.66. There was a difference of 0.46 gram per 100 ml. of blood between the means of the two seasons.

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[2] H. S. Brooks and J. S. Hughes, *Jour. Nutrition*, 5, 35 (1932).

[3] R. Gajardo, "A Study of the Erythrocyte and Leucocyte Counts and Hemoglobin Index of Red Sindhi and Holstein-Red Sindhi Crossbreds." (Thesis presented for graduation, College of Agriculture, 1954. Unpublished.)

TABLE 1.—*Analysis of variance of mean hemoglobin indices of Brown Swiss cattle*

SV	DF	SS	MS	COMPUTED F-VALUE
Month (M)	11	14.77	1.34	2.06 [a]
Animal (A)	5	40.82	8.16	12.55 [b]
M × A	55	35.54	0.65	1.08
Sampling error	72	43.37	0.60	
Total	143	134.50		

[a] Significant.
[b] Highly significant.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Mean	9.04	9.75	8.79	8.87	8.67	8.58
Month	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean	8.67	8.67	8.58	8.79	8.83	8.46
Animal No.	89	90	93	94	96	97
Mean	9.13	8.65	7.96	9.69	8.89	8.54

SMD at	5%	1%
Month (M)	0.66	0.85
Animal (A)	0.47	0.62

The slight increase in hemoglobin value during the summer agrees with the similar slight increase in Jersey, Guernsey, and Holstein bulls noted by Rusoff *et al.*[4] On the other hand, Gajardo [5] reported a slight decrease in the hemoglobin indices of Red Sindhi and Holstein-Red Sindhi crossbreds during summer. The Brown Swiss cows seemed not to be affected by the tropical climate and were in good condition throughout the experiment.

The correlation coefficient of the hemoglobin indices and atmospheric temperature was computed from the 24 observations made during the study. The value of r, being -0.207, was insignificant since r for 22 degrees of freedom at 5 per cent probability level is 0.404. This finding agrees with that of Manresa, Gomez, and Santos [6] who found hemoglobin index and atmospheric temperature to have an insignificant negative correlation of $-.226$. There was an insignificant correlation coefficient between relative humidity and hemoglobin content, the value of r being -0.105. The correlation coefficient of rainfall and hemoglobin index was -0.231. Calo [7] reported a negative correlation value of -0.297 for the same factors.

[4] L. L. Rusoff, J. E. Johnston, and C. Branton, *Jour. Dairy Sci.*, 37, 30 (1954).
[5] Gajardo, *op. cit.*
[6] M. Manresa, F. Gomez, and F. O. Santos, *Philippine Agriculturist*, 28, 79 (1939).
[7] L. L. Calo, "A Study of the Pulse Rate, Frequency of Respiration, Body Temperature, Hemoglobin Index, and Blood Cell Counts of Holstein-Friesian Dams and their Daughters." (Thesis presented for graduation from the College of Agriculture, 1954. Unpublished.)

Leucocyte count. The mean leucocyte count of the six Brown Swiss cows was 11.375 thousand per ml. of blood (table 2). This count falls within the range of 5.0 to 12.0 thousand per ml. of blood reported by Coffin.[8] There were significant monthly variations in the leucocyte counts at the 5 per cent probability level. Insignificant correlations were found between leucocyte count and the climatic factors. Calo [9] reported similar insignificant correlations.

TABLE 2.—*Analysis of variance of mean leucocyte counts of Brown Swiss cattle*

SV	DF	SS	MS	COMPUTED F-VALUE
Month (M)	11	780.89	70.99	6.81 [a]
Animal (A)	5	14.55	2.91	0.28
M × A	55	753.06	10.42	1.24
Sampling error	72	603.90	8.39	
Total	143	1,972.40		

[a] Highly significant.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Mean	10.254	11.075	9.942	11.088	8.792	7.471
Month	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean	12.121	15.571	12.725	11.533	15.666	10.258

SMD at	5%	1%
Month	2.639	3.515

Erythrocyte count. The average erythrocyte count of the six Brown Swiss cows was 4.761 million per ml. of blood (table 3). This result falls within the range reported by Malkmus.[10] There was no correlation between erythrocyte count and atmospheric temperature and rainfall. However, between erythrocyte count and relative humidity, the value of 0.403 was suggestive at the 5 per cent probability level with 22 degrees of freedom. The monthly means varied significantly at the 5 per cent probability level.

For an estimate of the hemoglobin content of each erythrocyte, the mean corpuscular hemoglobin in micro micrograms was computed. The mean corpuscular hemoglobin of the six Brown Swiss cows was 18.50 grams x 10-12. This value falls within the range of 14.4 to 18.6 for cattle reported by Coffin.[11]

[8] D. L. Coffin, "Manual of Veterinary Clinical Pathology," Comstock Publishing Company, Inc., Ithaca, New York, 1945, 236 pp.
[9] Calo, *op. cit.*
[10] B. Malkmus, "Clinical Diagnostics of the Internal Diseases of Domestic Animals," Alex Eger, Inc., Chicago, 1944, 11th ed., 302 pp.
[11] Coffin, *op. cit.*

TABLE 3.—*Analysis of variance of mean erythrocyte counts of Brown Swiss cattle*

SV	DF	SS	MS	COMPUTED F-VALUE
Month (M)	11	42.01	3.82	3.80 [a]
Animal (A)	5	7.30	1.46	1.45
M × A	55	55.25	1.01	1.58 [b]
Sampling error	72	45.79	0.64	
Total	143	150.36		

[a] Highly significant.
[b] Significant.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Mean	4.716	4.792	4.835	4.956	3.758	4.769
Month	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean	4.971	4.568	4.043	4.396	5.849	5.494

SMD at	5%	1%
Month (M)	0.822	1.094

A further study of the blood composition of the Brown Swiss breed will be of much help in determining if the values obtained in this experiment represent normal data and if the animals are adapted to our tropical climate.

It is not *what* the man of science believes that distinguishes him, but *how* and *why* he believes it. His beliefs are tentative, not dogmatic; they are based on evidence, not on authority or intuition.

—*Bertrand Russell*

GERMINATION AND GERMINATION INHIBITORS[1]

PAULINA D. PAGES

WITH TWENTY-ONE TEXT FIGURES

This study was undertaken to explore the possibility of controlling weeds through inhibition of germination. Four chemicals (maleic hydrazide, 2,4-dichlorophenoxyacetic acid, coumarin, and p-chlorophenyl dimethylurea) were tried at various concentrations on seeds of three weed species (*Ipomoea triloba* L., *Echinochloa crusgalli* L., and *Amaranthus spinosus* L.) and rice.

Maleic hydrazide suppressed root growth and shoot development of all the species, but was least effective on Ipomoea. Being effective on most narrow-leaved plants, especially grasses, MH is not practical to use in rice fields because the crop may be injured.

The most promising chemical is 2,4-dichlorophenoxyacetic acid (2,4-D) because it required the least concentrations to completely inhibit the seeds. It was more severe on the broad-leaved species, *I. triloba* and *A. spinosus*. The duration of its effectiveness in the soil, however, needs to be known so that seeding of the rice crop can be properly timed.

It is clear that coumarin is not a selective herbicide. It may, however, be useful in prolonging the life span of certain seeds by inducing dormancy.

CMU or p-chlorophenyl dimethylurea at concentrations of 2 per cent or below is definitely not a germination inhibitor but a straight-growth inhibitor. It is not a selective herbicide.

An attempt was made to relate the mechanism of inhibition by maleic hydrazide to its effect on water absorption. The result seems to indicate that the action of the chemical is linked more with active water absorption rather than with the physical processes of imbibition and diffusion.

The eradication of weeds constitutes one of the greatest problems in agriculture. Numerous scientific investigations have been aimed at the solution of this universal problem. Chemical weed control started as early as 1899 when Jones and Orton reported the use of sodium chloride, iron sulfate, copper sulfate, and sodium arsenite as selective herbicides. Its many disadvantages (Ahlgren *et al.*, 1950), such as high cost of materials per acre, explosion and fire

[1] Central Experiment Station Contribution No. 1850. Condensed from the thesis presented by the author in partial fulfillment of the requirements for the degree of Master of Science in Botany, 1954. Prepared in the Department of Agricultural Botany under the direction of Drs. J. R. Velasco and Jose M. Capinpin.

hazard, equipment corrosion, and moderate success in weed eradication, rendered the approach unattractive for some time.

In 1938, with the release of Sinox by French workers, interest in chemical weeding was rekindled and the search for weed killers became intensified. Slade, Templeman, and Sexton (1940) of England noted that alpha-naphthylacetic acid killed the weeds while oat plants received only a slight setback. Following experiments confirmed this finding, and thus was recognized the selective phytocidal action of certain growth substances. Independently, Beal (1944), Mitchell and Hamner (1944), and Hamner and Tukey (1944) suggested the possible use of synthetic growth substances as selective weed killers.

Most published experiments on chemical weed control are concerned with the eradication of growing weeds in the field. Prevention of germination seems to the writer to have certain advantages which should be explored. First, the crop would not suffer from competition for nutrients and space with the weeds. Second, prevention of weed seed germination may require less chemical than eradication of growing weeds.

The present study aims (1) to determine the minimum concentrations of four synthetic growth substances which will inhibit the germination of palay and three weed seeds and (2) to characterize the various effects on germination of these substances at different concentrations in terms of primary root growth and general appearance of the shoot.

The series of experiments were conducted in the laboratory and greenhouse of the Department of Agricultural Botany, UP College of Agriculture and Central Experiment Station, from November, 1953, to September, 1954.

MATERIALS AND METHODS

Amaranthus spinosus L., *Ipomoea triloba* L., and *Echinochloa crusgalli* L.[2] were chosen for study among the many pernicious weeds in rice fields because they are, in the main, propagated by seed; hence the attractive prospect of controlling them by preventing seed germination. The first two species are serious in upland rice fields, and the third species is very troublesome in lowland rice fields in this vicinity. It should be mentioned in passing that they belong to wide-

[2] *Amaranthus spinosus* L. is locally known as *uray; Ipomoea triloba* L., as *camote-camotehan;* and *Echinochloa crusgalli* L., as *bayokibok* or, in English, as water-grass or barnyard grass. In the discussion they will be referred to only by their generic names.

ly divergent families—Amaranthaceae, Convolvulaceae, and Gramineae, respectively. Testing them will thus indicate in which region of the plant kingdom a particular chemical can be most effective.

To find the effect of the chemicals on the rice crop, seeds of Inintiw 107 were used.[3]

Maleic hydrazide, coumarin, Shell 2,4-D, and CMU were the chemicals tested.

Maleic hydrazide [4] (MH-40) is a white, dry, water-soluble powder formulation of the sodium salt of maleic hydrazide, containing 40 per cent active ingredient. Free maleic hydrazide has the chemical formula $C_4H_4N_2O_2$. The concentrations of maleic hydrazide used in these experiments ranged from 0.01 to 0.5 per cent. Complete solubility in water is at 0.4 per cent.

Coumarin comes in the form of white crystals, insoluble in water but soluble in ethanol and very soluble in ether. It is chemically known as O-hydroxy-cis-cinnamic acid with the formula $C_9H_6O_2$. This compound has a very pleasant scent. To prepare a 0.1 per cent stock solution, 100 mg. of the crystals were dissolved in 3 ml. of 95 per cent ethanol and brought up to 100 ml. of solution with distilled water. The range of concentrations used was from 0.0025 to 0.1 per cent.

CMU (p-chlorophenyl dimethylurea) is a greyish white solid with a faint characteristic odor and is slightly soluble in water. It has the chemical formula $C_9H_{11}ClN_2O$. The compound is available in the form of a wettable powder that stays in suspension with agitation. The concentrations used ranged from 0.025 to 2 per cent. Distributors of the product report that it can destroy all vegetation, leaving the soil weed free for 12 months, and that best results are obtained when it is applied to the ground for root absorption.

Shell 2,4-D [5] is an isopropyl ester of 2,4-D (2,4-dichlorophenoxyacetic acid) in an emulsifiable oil which may be diluted with water or oil. It has the chemical formula $C_8H_6Cl_2O_3$. The concentrations used ranged from 0.00125 to 0.1 per cent.

In general, the seeds were germinated on a layer of filter paper in Petri dishes. One hundred seeds were scattered uniformly on the

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[3] The generosity of the Division of Plant Breeding in furnishing the rice seeds is acknowledged.

[4] The sample was a gift of the Naugatuck Chemical International through its local agent, the Gregorio Araneta Inc.

[5] This gift of 2,4-D by the Shell Company (Philippines) to the Department of Agricultural Botany is acknowledged.

filter paper; then just enough water or solution of a chemical was added for the seeds to "break surface."

The filter paper insured sufficient moisture in all parts of the Petri dish, thus correcting for differences in level of the bottom of the dish. It also served to hold the seeds in position so that when the dish was handled, the seeds did not roll from one side to another and in so doing alter the polarity of the seedlings.

Just enough water or solution was added so that the oxygen supply would not be limited.

In some experiments, the inhibitory effect of the chemical was selective on certain parts of the plant. It was not uncommon to find a seedling with a well-developed plumule without any root. In other cases the coleoptile was abnormally long, but the first leaf was conspicuously stunted. As follow-up these seedlings were planted in soil and grown under greenhouse conditions.

EXPERIMENTS AND RESULTS

Preliminary experiments on germination

The germination characteristics of the three weed species were studied to find the conditions under which germination of seeds could be simultaneous and at a high percentage.

Effect of varied light conditions on germination. Duplicate lots of 100 seeds each were germinated on filter paper in Petri dishes or in sand in small pots and subjected to diffused light in the laboratory, to light in the greenhouse, or to direct sunlight. There were, therefore, 12 treatments in all. This experiment was undertaken because some seeds, like papaya seeds, do not germinate in Petri dishes, although they do in sand or in soil. There are also seeds, like lettuce seeds, which are light sensitive and germinate best in direct sunlight.

The results showed that rice seeds had 96 to 98 per cent germination in either medium and under any of the light conditions.

Echinochloa germinated better in the greenhouse and in direct sunlight, but as a whole, its germination was very low. Since the seeds used were old ones, their failure to germinate satisfactorily was attributed to reduced viability in storage. Newly harvested seeds gave 60 to 75 germination percentages in the greenhouse and hardly any germination (0 and 2 per cent) in the laboratory. This result was taken as an indication that this type of seed is light sensitive. Later studies were all carried out in the greenhouse with newly harvested seeds.

Ipomoea seeds gave 90 to 95 per cent germination under any of the light conditions. The seeds used in this experiment were plump and newly harvested. The dried-up seeds, however, would not germinate at all.

On the other hand, Amaranthus did not germinate in either medium or under any of the light conditions. Being newly harvested, the seeds were believed to be viable but in a dormant condition.

Pretreatment of Ipomoea. It was thought that the dried-up Ipomoea seeds must be undergoing what has been termed as secondary dormancy (Crocker, 1948), brought about by unfavorable germination conditions after harvest. Dormancy is ascribable to either one or a combination of the following general causes: a hard impermeable seed coat, a certain chemical mechanism which is related to light, a dormant embryo, and a naturally occurring chemical inhibitor. In Ipomoea, the probability of a dormant embryo causing failure to germinate can be excluded because the fresh plump seeds readily germinated.

Means by which the dried-up seeds could be thrown out of dormancy were then sought by testing the following pregermination treatments: (1) alternate wetting and drying (three days of each), (2) heating for 10 minutes in hot water at 60°C., then suddenly immersing in ordinary tap water, (3) heating in the oven (40°C. to 56°C.) for 15 hours, (4) soaking in concentrated sulfuric acid for 5 minutes and thoroughly washing in running water for 10 minutes.

Treatment 1 attempts to simulate the alternate wetting and drying of the seed during a succession of rain and sunshine. This treatment may do either or both of two things. The alternate swelling and shrinking may cause the formation of crevices in the seed coat through which water and oxygen can pass, and the water may wash off any naturally occurring chemical that inhibits germination. Treatments 2 and 3 are ways of destroying some chemicals or upsetting certain mechanisms like the respiratory processes to induce germination. And treatment 4 may break the impermeable seed coat or generate heat to upset respiration.

The seeds were germinated in Petri dishes with moist filter paper in the laboratory in duplicate tests. Treatments 1 and 2 had no effect whatsoever. Treatment 3 gave 24 and 25 per cent germination, and treatment 4, 90 and 91 per cent.

The results of treatment 3 suggested that heat possibly increased germination. The much higher germination percentage of the seeds

presoaked in sulfuric acid inspired further exploration on this pretreatment. To determine the optimum pregermination soaking period in acid, subsequent tests were made in 6 replicates using a hundred seeds each, at soaking periods of 3 minutes, 6 minutes, 24 minutes, 48 minutes, and 96 minutes. This was followed by thorough washing in running water for 10 minutes before setting in the germinators.

While the 24-minute treatment gave the highest percentage germination (table 1), it was not too desirable because some of the seedlings had brownish, apparently injured radicle tips. The second highest percentage germination was obtained from seeds soaked for 6 minutes, and these produced all normal seedlings. The percentage germination in this treatment did not, however, differ significantly from that of the 12-minute treatment. All Ipomoea seeds subsequently used were pretreated with concentrated sulfuric acid for 6 minutes and washed thoroughly in running water for 10 minutes prior to germination.

TABLE 1.—*Percentage of germination at different periods of soaking in concentrated H_2SO_4 prior to planting*

TREATMENT OF SULFURIC ACID	REPLICATION						AVERAGE
	1	2	3	4	5	6	
3 minutes	80	80	77	56	68	44	67.5
6 minutes	95	97	99	90	96	93	95
12 minutes	94	95	93	96	91	92	95.5
24 minutes	99	97	97	94	92	93	93.3
48 minutes	98	94	93	91	94	92	93.7
95 minutes	97	93	97	95	95	93	95
Control [a]	0	0	0	1	0	2	

[a] Control is excluded in the analysis.

Analysis of variance by angular transformation

SOURCE OF VARIATION	DF	SS	MS	COMPUTED F	TABULAR F	
					5%	1%
Treatment	5	2278.38	455.68	30.54	2.60	3.86
Replication	5	537.57	63.51	4.26	2.60	3.86
Rep. × Treat.	25	372.95	14.92			
Total	35	2968.90				

L.S.M.D. = 5.75°

To determine the mechanism of the sulfuric acid effect on the germination of Ipomoea, portions of the seed coats of 10 seeds were pared off with a sharp blade, and these scarified seeds were germinated. A parallel control lot of 10 untreated seeds was run with the scarified lot. All scarified seeds germinated overnight, but the control seeds did not show any sign of germination even up to the third day. This test was to find whether or not the effect of the sulfuric acid was to eat away the seed coat, which is suspected to be a barrier to germination. The result points out clearly that the corroding action of the acid on the seed coat was the cause of germination.

The effect of increased temperature produced by the action of sulfuric acid on the seed coat was considered an alternative cause of increased germination. A thermometer was inserted slightly into a dish of 100 seeds soaked in concentrated sulfuric acid. The reading obtained was 34°C. when the room temperature at the time was 29°C. This temperature was much less than that used in a previous pretreatment which gave a percentage germination of 25 per cent, and so it was concluded that temperature does not play a major role in the sulfuric acid effect on germination.

That sulfuric acid may have a destructive effect on some germination inhibitors which may be present on the seed coat was another possibility. Ten Ipomoea seeds and ten rice seeds were germinated together in one Petri dish, and a control dish with 10 sulfuric acid-pretreated Ipomoea seeds and 10 palay was run as a parallel test. The inhibition or reduction of germination of rice seeds in the first dish would mean the presence of inhibitors on the seed coats of the Ipomoea. No difference in results was exhibited by the two dishes, implying that there were no germination inhibitors in the untreated Ipomoea seeds.

Pretreatment of Amaranthus. Three possible causes of failure of Amaranthus seeds to germinate were suspected: (1) that inhibiting chemicals were present on the seed coats or in the seeds themselves, (2) that, as in Ipomoea, the seed coat constituted a barrier to water absorption and oxygen supply, (3) that after-ripening was needed for the seeds to germinate.

The following pretreatments were tried to explore these possibilities: (1) holding under running water for 12 hours to wash out any inhibiting substance that may be present on the seed coat followed by heating at 70°C. in the oven for 12 hours, (2) soaking in concentrated sulfuric acid at various periods of 20 minutes, 25 minutes, and 30 minutes, (3) subjecting to low temperature (6°C. to

16°C.) at varying periods of three days, one week, two weeks, three weeks, four weeks, five weeks, and six weeks from 7:00 a.m. to 7:00 p.m. daily, under moist or dry conditions. In the last pretreatment the seeds were kept moist between two layers of moist filter paper in Petri dishes. Those which were to remain dry were kept in a Petri dish without filter paper; from it samples for germination were taken each week for six weeks.

Only 2 per cent germination was obtained from the first treatment. This, it was thought, excluded the possible presence of inhibiting substances on the seed coats. Soaking in sulfuric acid for 20, 25, and 30 minutes gave 37, 32, and 35 per cent germination, respectively. That the seed coat presents a barrier to germination in Amaranthus was indicated, and further tests on this pretreatment would have been tried had not the cold treatment given satisfactory results.

Subjection to low temperature for one week gave 82 per cent germination. No germination was obtained from seeds kept at a low temperature for only three days. Seeds subjected to cold treatment for two to six weeks were practically all germinated upon examination, and some had developed into seedlings with reddish, expanded cotyledons while still in the medium.

Cold treatment for one week was further tried using 6 replicates of 100 seeds each; these gave a mean germination of 79 per cent. It was decided that for the purpose of the present study the cold treatment for one week was best since within this period no seed started to germinate in the medium and the percentage germination obtained was satisfactory.

The changes that take place in the dormant embryo during low temperature are imbibition of water or increase in water absorption, increase in enzymatic activity, accumulation of simple organic materials like sugars and amino acids, transformation of insoluble, osmotically inactive substances to soluble, osmotically active ones, as fats to sugars and insoluble proteins to soluble proteins, amino acids, and other nitrogenous compounds (Eckerson, 1913; Pack, 1921; Flemion, 1934; Afanasiev and Cress, 1942; Crocker, 1948).

Effects of maleic hydrazide on germination

Three concentrations, 0.5 per cent, 0.25 per cent, and 0.125 per cent, were used on rice and Ipomoea seeds. A control of untreated seeds was set up. For rice the liquid added to each Petri dish was 10 ml., and for Ipomoea, 8 ml. The initial level of the liquid was maintained as much as possible during the experiment. Six replica-

tions were run and the rate of germination of seeds was determined at suitable intervals. In these experiments, seeds were regarded as germinated when any organ had attained a length of not less than 1.5 mm. (Taylor, 1942).

For Echinochloa and Amaranthus, 0.4 per cent, 0.2 per cent, and 0.1 per cent solutions were used. A control was again maintained. Five ml. of liquid was added to each Petri dish. The Amaranthus seeds, being very minute, were apportioned by means of an improvised scoop that held more or less a hundred.

On all the seeds tested, germination inhibition [6] and straight-growth inhibition [7] were observed. Inhibition of organ development

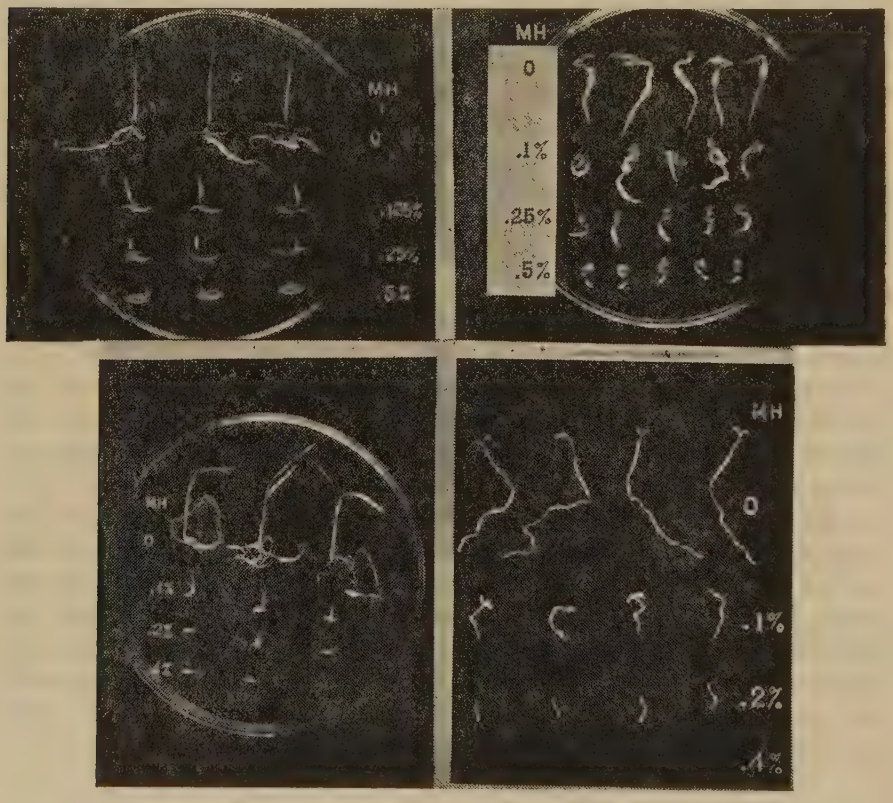

Fig. 1.—Upper panel, left—rice treated with MH, 5 days after seeding; right—*I. triloba* treated with MH, 36 hours after seedling; lower panel, left—*E. crusgalli* treated with MH, 13 days after seeding; right—*A. spinosus* treated with MH, 5 days after seeding.

[6] Inhibition of processes in the seed before any organ emerges through the seed coat.

[7] Inhibition after an organ has emerged through the seed coat.

and reduction of germination percentage diminished with increasing dilution down to the least concentration of maleic hydrazide in this study.

Effect on palay. While control seedlings, five days after planting, were healthy and green with well-developed roots, among the seeds treated with 0.25 and 0.125 per cent concentrations only the coleoptiles had emerged, and no signs of the plumule were evident even in those whose coleoptile tips had split open (fig. 1, upper left). On the other hand, the exposed radicles in these lots were much shorter than the coleoptiles, which is not typical. At the maximum concentration the exposed radicles measured 2 mm. in length, whereas in most of the seeds no radicle was produced.

The seeds treated with 0.125 per cent solution showed almost complete inhibition until the 74th hour after seeding (fig. 2). The coleoptiles, after having broken through the seed coats, increased in length at a considerably slow rate as shown by the fact that five days after seeding they ranged from 1.5 to 4 mm., in contrast with

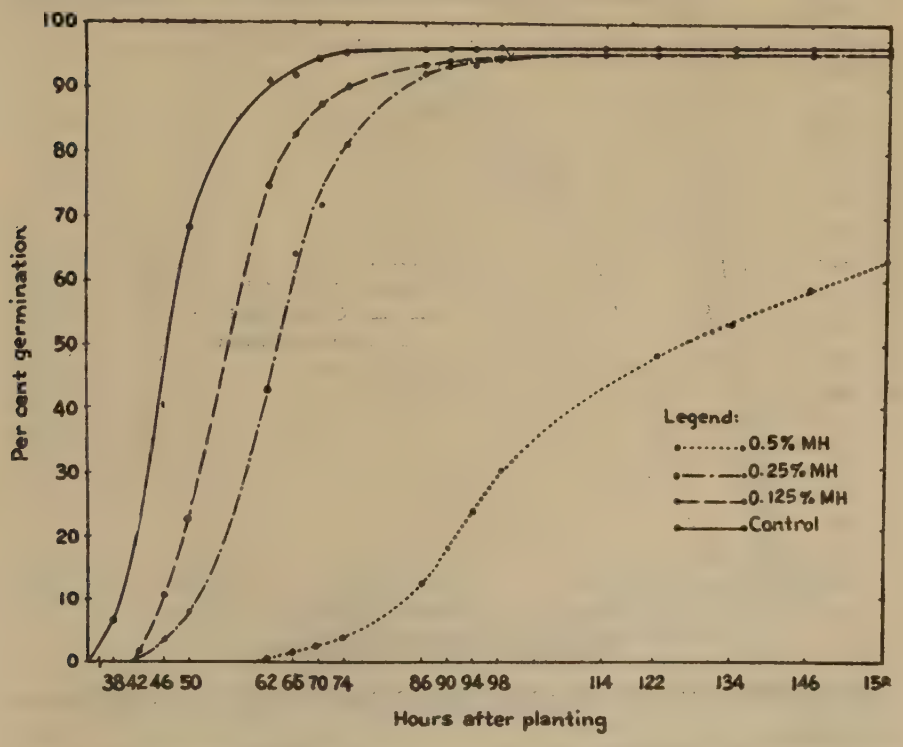

Fig. 2.—Effect of MH on percentage germination of rice at various hours.

the 5 to 14 mm. coleoptile lengths of the other two treatments and in greater contrast with the 20 to 30 mm. range of plumule length of the control.

In the test plantings of six-day-old seedlings in small pots in the greenhouse, all treated seeds which were considered germinated died shortly after planting.

Effect on Ipomoea. Thirty-six hours after seeding, the control and seeds treated with 0.1 and 0.25 per cent MH had attained 90 per cent germination, but the hypocotyls [8] of the treated seeds were visibly shorter than those of the control (figs. 1 and 3). While the control had almost 90 per cent germination 22 hours after seeding, the seeds treated with 0.5 per cent exhibited this germination percentage only on the 71st hour.

Root hairs were abundant around the tip of the radicles of the control at 36 hours and secondary roots were evident on the third

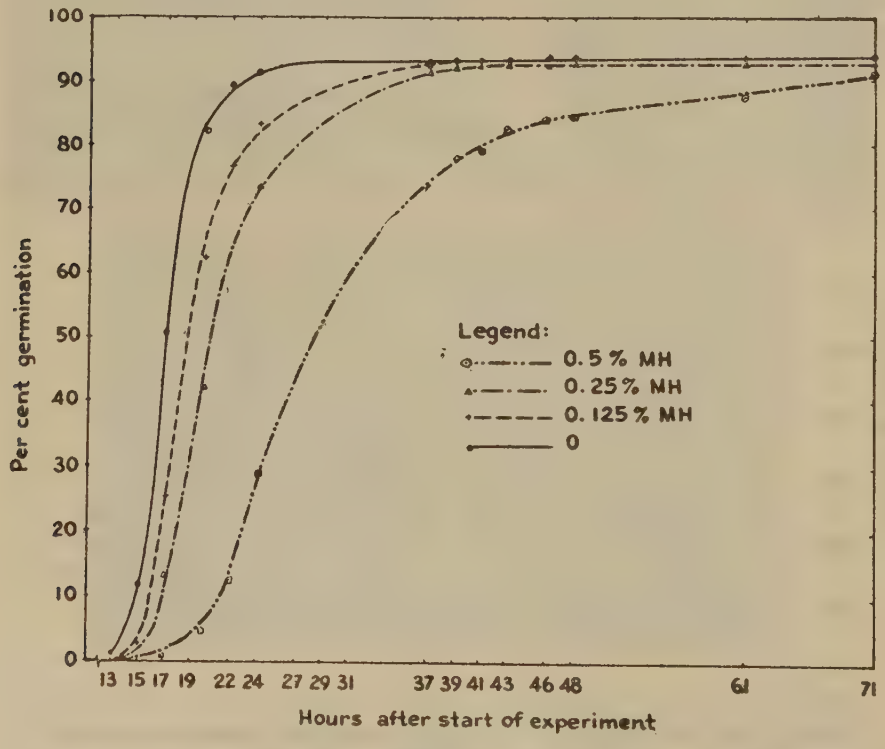

Fig. 3.—Effect of MH on percentage germination of *I. triloba* at various hours.

[8] Measured from the base of the cotyledons to the tip of the radicle.

day. Neither root hairs nor secondary roots were formed among the treated seeds.

The hypocotyls at the end of the experiment had the following mean lengths: control—7.6 cm.; 0.125 per cent—1.7 cm.; 0.25 per cent—1.1 cm.; 0.5 per cent—0.5 cm. The first three lots had fully emerged hypocotyls. The expanded cotyledons of the treated seeds were yellowish green, differing visibly from the dark green of the control.

Three-day-old germinated seeds planted in the greenhouse showed the following results after one week: control—in addition to fully expanded cotyledons, two true leaves and an average height of 9 cm. (average of five plants); 0.125 per cent treatment—greener and larger cotyledons, but hardly any increase in height of seedling (average height of five plants—0.4 cm.); 0.25 per cent treatment—greener and slightly larger cotyledons, but no apparent increase in height; 0.5 per cent treatment—of 10 plants, only one had cotyledons which emerged through the soil and these were small and unhealthy and did not visibly grow after emergence from the soil.

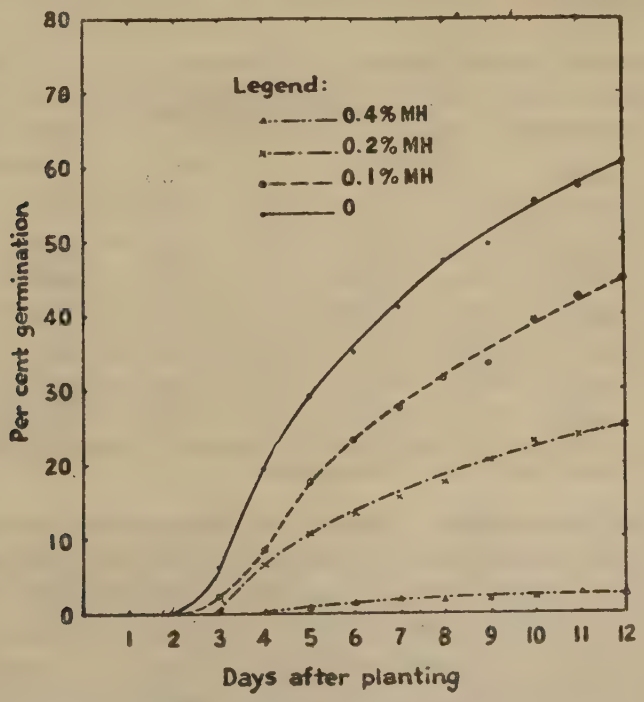

Fig. 4.—Effect of MH on percentage germination of *E. crusgalli* at various days.

Effect on Echinochloa. An apparent delay and reduction in germination was observed among the treated seeds. There was no sign of germination among the seeds in five replicates out of six treated with 0.4 per cent MH on the 13th day after seeding.

Seven days after planting, a little over 10 per cent of the seeds treated with 0.2 per cent solution germinated, but until the 13th day, no plumules emerged through the coleoptiles and the roots were visibly stunted and almost undeveloped (figs. 1 and 4). A greenish color within the coleoptile, especially towards the base, was however visible.

The seeds treated with 0.1 MH showed almost the same results as those treated with 0.2 per cent, except that they had greater germination percentages. Thirteen days after seeding, only one out of those which germinated as early as the sixth day had part of the first leaf unfolded. The rest had coleoptiles encasing the plumules.

Table 2 shows measurements of the roots and shoots of five plants picked at random.

All plantings in the greenhouse of the germinated treated seeds were unsuccessful.

TABLE 2.—*Length of shoots and roots of Echinochloa crusgalli seedlings*[a]

TREATMENT	PLANT ORGAN	LENGTH IN CENTIMETERS					AVERAGE
		1	2	3	4	5	
.4%	Shoot	0.25	0.35	0.25	0.3	0.3	0.29
	Root	0	0	0	0	0	0
.2%	Shoot	0.4	0.3	0.5	0.6	0.55	0.51
	Root	0.1	0.25	0.2	0.2	0.25	0.2
.1%	Shoot	0.6	0.7	0.6	0.6	0.7	0.64
	Root	0.35	0.6	0.55	0.6	0.6	0.48
0	Shoot	3.9	2.7	4.1	5.5	4.8	4.16
	Root	5.0	4.2	12.7	7.0	6.7	7.32

[a] Measurements taken 15 days after seeding.

Effect on Amaranthus. Stunted seedlings grew from the treated seeds (fig. 1, lower right). Those treated with 0.1 per cent MH appeared normal except for their small size. Those treated with 0.2 per cent MH indicated a slight change in the polarity of the seedlings, were quite delayed in germination, and had a very low germination percentage (7.75 per cent) at the end of the experiment (fig. 5). No germination was obtained from the 0.4 per cent treatment.

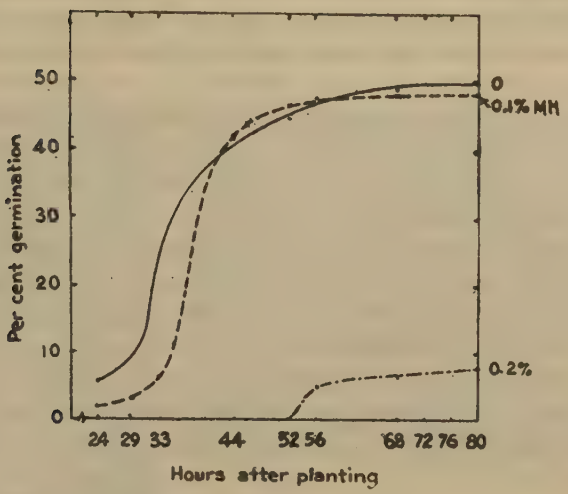

Fig. 5.—Effect of MH on percentage germination of *A. spinosus* at various hours.

An unusual rise in germination of seeds treated with 0.1 per cent MH was observed 44 hours after seeding. This was the only instance in this study where a stimulatory effect by a chemical was observed. Not much weight should be given to this observation, however, since the control eventually surpassed this lot at the end of the experiment.

An abundance of literature on maleic hydrazide as a plant growth regulator has been written since 1949 when Schoene and Hoffman observed its "pronounced but temporary inhibiting effect" on plants.

Currier, Day, and Crafts (1951) reported that the age of the plant was decisive, the older grasses, for instance, being less susceptible than young grasses; that in general grasses were more susceptible to maleic hydrazide than broad-leaved plants; and that broad-leaved plants were more tolerant the more mature they were at spraying time.

Among other possible physiological effects of maleic hydrazide causing growth inhibition in plants and plant organs are the following: (1) interference with water relations (Naylor and Davis, 1950), (2) interference with auxin metabolism leading to loss in apical dominance (Leopold and Klein, 1951), (3) cessation of activity of terminal meristem, leading to suppression of root and top growth (Greulach and Atchison, 1950; Darlington and McLeish, 1951; Greulach and Atchison, 1953; Greulach and Haesloop, 1954).

The morphological manifestations of suppression of root and epicotyl growth suggest the cessation of terminal meristem activity. The observation that palay and Echinochloa showed more sensitivity to maleic hydrazide than Ipomoea is consistent with the observation of various investigators that narrow-leaved plants are more susceptible to this growth substance than broad-leaved plants. That this selectivity of maleic hydrazide does not depend upon the external morphological characters of the plant tissue where application is made but rather upon the differential reactivity of the protoplasm of narrow-leaved and broad-leaved plants is clearly pointed out here. Thus, while after nine hours the seed coat of Ipomoea ruptured, exposing the embryo to the chemical more intimately and presumably to more injury, palay and Echinochloa seeds were never ruptured during the whole period of germination. It may be mentioned that the chemical, while effective perhaps at suitable concentrations on most narrow-leaved weeds like grasses, is not practicable for application in rice fields, unless perhaps when the residual effect of maleic hydrazide in the soil is known and soil planting of the rice seeds can be timed to escape the injurious effect of the chemical.

Effects of 2,4-D on germination

The same experimental technique used with maleic hydrazide was followed with 2,4-D, except for the different concentrations. For rice, concentrations of 0.1 per cent, 0.5 per cent, and 0.025 per cent were used, and for Echinochloa, 0.05 per cent, 0.025 per cent, and 0.0125 per cent. The concentrations for Ipomoea and Amaranthus were much lower: 0.005 per cent, 0.0025 per cent, and 0.00125 per cent for Ipomoea and 0.01 per cent, 0.005 per cent, and 0.0025 per cent for Amaranthus. Duration of observation depended on the rate of germination of a particular type of seed.

Ipomoea and Amaranthus were much more sensitive to 2,4-D than palay and Echinochloa. One interesting effect of this inhibitor was that it changed the polarity of the coleoptiles and plumules. All the germinated treated seeds of rice and weeds had epicotyls conspicuously flat on the moist filter paper.

Effect on palay. Among the treated seeds, no signs of the plumules were evident and the coleoptiles were abnormally long and hooked at the tip (fig. 6, upper left). Seven days after seeding, the coleoptiles of some of the seeds treated with 0.025 per cent 2,4-D had attained a length of 4.4 cm.; the normal coleoptile length ranged from 0.6 to 1 cm. Even at this concentration, radicles completely

failed to emerge. Much shorter coleoptile growth was observed in the other two treatments: 1.4 cm. in the 0.05 per cent treatment and 0.6 cm. in the 0.1 per cent treatment.

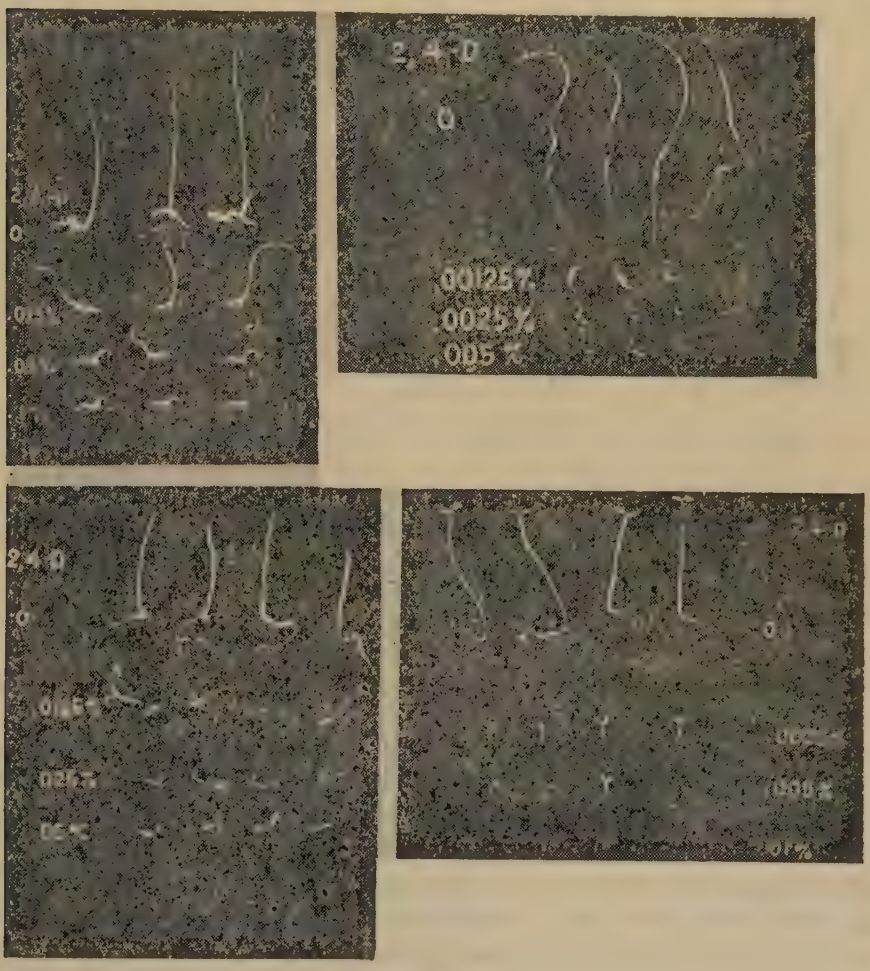

Fig. 6.—Upper panel, left—rice treated with 2,4-D, 5 days after seeding; right—*I. triloba* treated with 2,4-D, 4 days after seeding; lower panel, left—*E. crusgalli* treated with 2,4-D, 10 days after seeding; right—*A. spinosus* treated with 2,4-D, 5 days after seeding.

Fig. 7 shows the percentage germination of treated rice at various hours.

Plantings in the greenhouse of the germinated treated seeds were all unsuccessful.

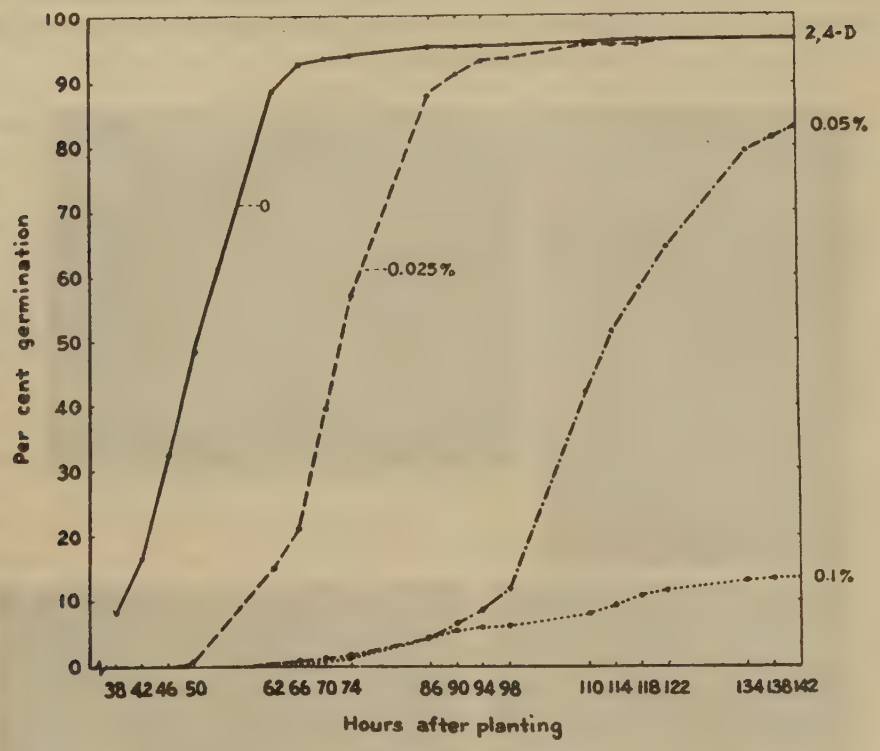

Fig. 7.—Effect of 2,4-D on percentage germination of rice at various hours.

Effect on Ipomoea. The inhibitory effect of 2,4-D on Ipomoea was impressively marked. Concentrations of 0.1 per cent, 0.05 per cent, 0.025 per cent, and 0.0125 per cent completely inhibited germination in six replicates of each treatment. A maximum mean germination of 22 per cent was achieved in treatment 0.005 per cent 74 hours after seeding, in great contrast with the 95 per cent germination in the control on the 26th hour (fig. 8).

The treated seeds that germinated produced stunted seedlings (fig. 6, upper right). Four days after seeding, the average lengths of hypocotyls of five plants picked at random were as follows: control—10 cm.; 0.00125 per cent—22 cm.; 0.0025 per cent—0.4 cm.; 0.005 per cent—0.36 cm. The radicles had brownish tips on the fourth day, indicating the start of decay, and the ungerminated seeds with ruptured seed coats were rotting. The emerged cotyledons were almost colorless in contrast with the dark green of the control.

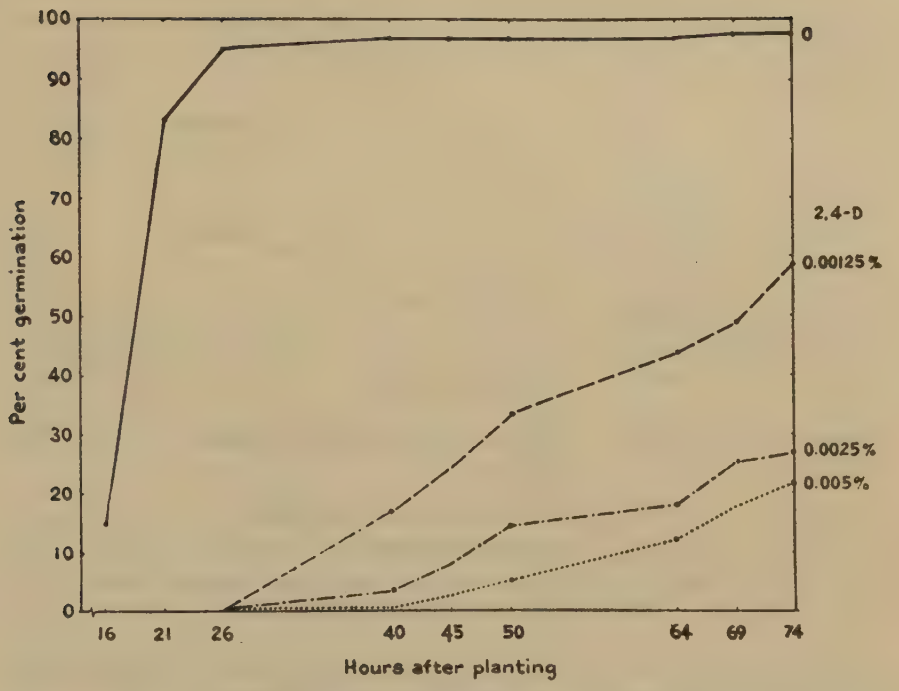

Fig. 8.—Effect of 2,4-D on percentage germination of *I. triloba* at various hours.

Germinated treated seeds planted in the greenhouse did not live.

Effect on Echinochloa. Complete inhibition was effected at 0.1 per cent concentration. While a mean germination of 43 per cent was achieved by seeds treated with 0.025 per cent 2,4-D (fig. 9), the resulting abnormal seedlings did not live long when planted in the greenhouse. Seedlings of those treated with 0.0125 per cent lived but developed very slowly so that after one week in the greenhouse they had only two small leaves which, on the average, were 1.5 cm. long. They differed greatly from the check plants which had four leaves with an average length of 9 cm.

At 0.05 per cent, coleoptiles were empty (fig, 6, lower left), and at the end of the observation in the laboratory, all seedlings which were considered germinated had died. Treatment with 0.025 per cent produced faintly greenish coleoptiles which all lay flat on the filter paper with no roots at all. These, also, were beginning to turn brownish. Rarely did unhealthy plumules emerge through the faintly green coleoptiles of seedlings from seeds treated with

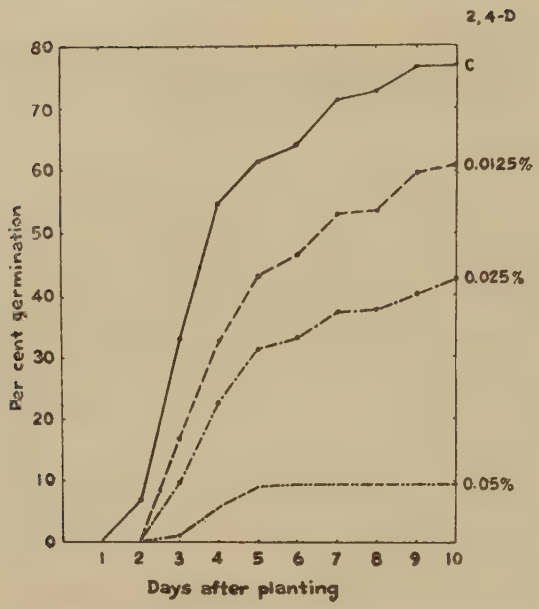

FIG. 9.—Effect of 2,4-D on percentage germination of *E. crusgalli* at various days.

0.0125 per cent. Like those of the preceding treatment, these coleoptiles were never upright and evidenced no radicles.

Effect on Amaranthus. Inhibition of germination was complete among Amaranthus seeds treated with 0.01 per cent solution; even with 0.005 concentration almost complete inhibition was effected (fig. 10). Sixty-nine hours after seeding, while maximum germination was observed in the control, seeds treated with 0.0025 per cent were just beginning to germinate. Those treated with 0.005 per cent began to germinate only on the 149th hour.

There was not only marked germination inhibition but also straight-growth inhibition. The following averages of measurements of the hypocotyls taken from five plants picked at random clearly support these observations: control—39 mm., 0.0025 per cent—11 mm.; 0.005 per cent—2.2 mm. The diminutive seedlings were not upright and the radicles near the tip developed tufts of root-hair-like structures (fig. 6, lower right).

All plantings in the greenhouse of the germinated treated seeds were unsuccessful.

In this experiment, palay and Echinochloa required much higher minimum concentrations for inhibition than Ipomoea and

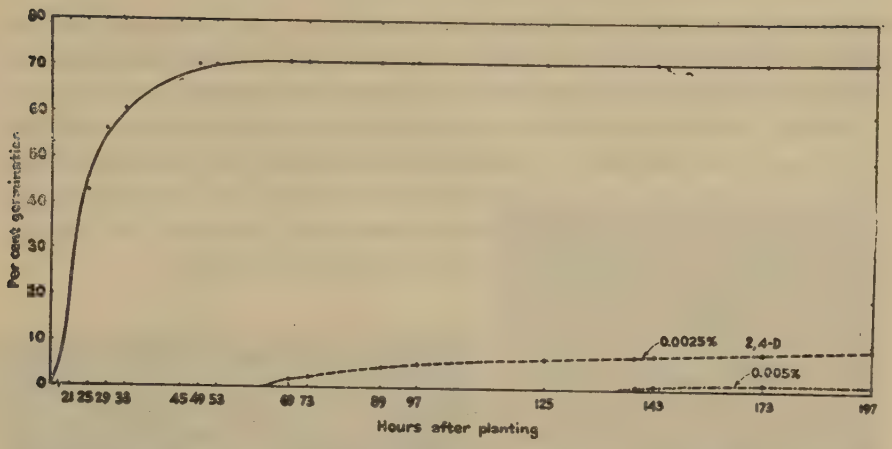

Fig. 10.—Effect of 2,4-D on percentage germination of *A. spinosus* at various hours.

Amaranthus. This substantiates previous findings that grasses as a group are more resistant than dicotyledonous plants, both to selective 2,4-D sprays above the ground and to treatments incorporating the chemical in the soil (Jorgensen and Hamner, 1948). Hamner and Tukey's (1944) suggestion of a light surface application prior to seeding may prove beneficial in combination with the present findings. This may be practicable, however, only for dictoyledonous weeds.

Though the basic causes for the herbicidal effects of 2,4-D remain obscure (Ahlgren *et al.*, 1951), its action is known to be appreciably different from that of other chemicals, for it kills by regulation of growth, stimulation of meristems, and exhaustion of food reserves rather than by direct necrosis and dehydration of exposed tissues (McNew and Hoffman, 1950).

Hamner, Moulton, and Tukey (1946) suggest the application of a lethal dose of the acid to the soil as a method of eliminating weeds. Residual effect of the chemical was tested and found to be active in muck for only a few weeks, 2,4-D apparently either leaching out or changing form. They pointed out that this is a method of sterilizing the soil of weed seeds which leaves the soil unusable for only a relatively short period of time.

Effects of coumarin on germination

The same experimental technique was used with coumarin as with the two preceding chemicals. Concentrations of 0.05 per cent,

0.025 per cent, and 0.0125 per cent were tried on rice and Echinochloa; 0.1 per cent, 0.05 per cent, and 0.025 per cent on Ipomoea; and 0.02 per cent, 0.01 per cent, and 0.005 per cent on Amaranthus.

Palay was more sensitive to this inhibitor than either Ipomoea or Echinochloa, although Amaranthus exhibited the greatest sensitivity. Suppression of root growth was evident and morphological effects in the emerged organs were manifest, especially in Echinochloa. Polarity of the seedlings was not visibly affected.

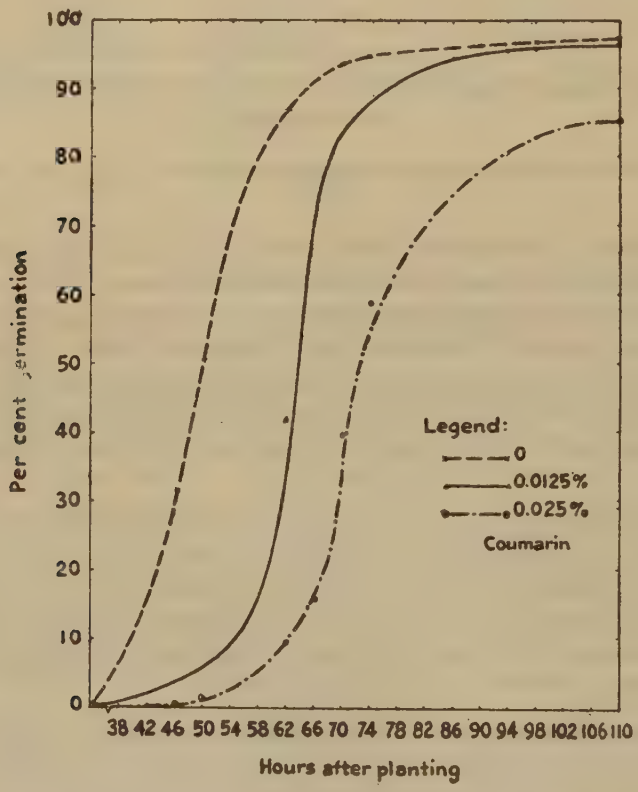

Fig. 11.—Effect of coumarin on percentage germination of rice at various hours.

Effect on palay. Complete inhibition of palay was obtained at 0.1 per cent concentration (fig. 11). While 0.05 per cent allowed some coleoptile tips to break through the hulls, the emerged organs never attained a length of 1.5 mm., and thus the seedlings were not considered germinated. The emerging coleoptiles in the other treatments manifested abnormality of tissues by their enlarged size and

bloated form (fig. 12, upper left). The delayed emergence of organs gives the impression that there was difficulty in breaking through. No sign of the radicles attaining a length of 1.5 mm. was observed. Some of the coleoptiles broke off at the base after attaining a length of 2 mm. or more, suggesting brittleness or overturgidity.

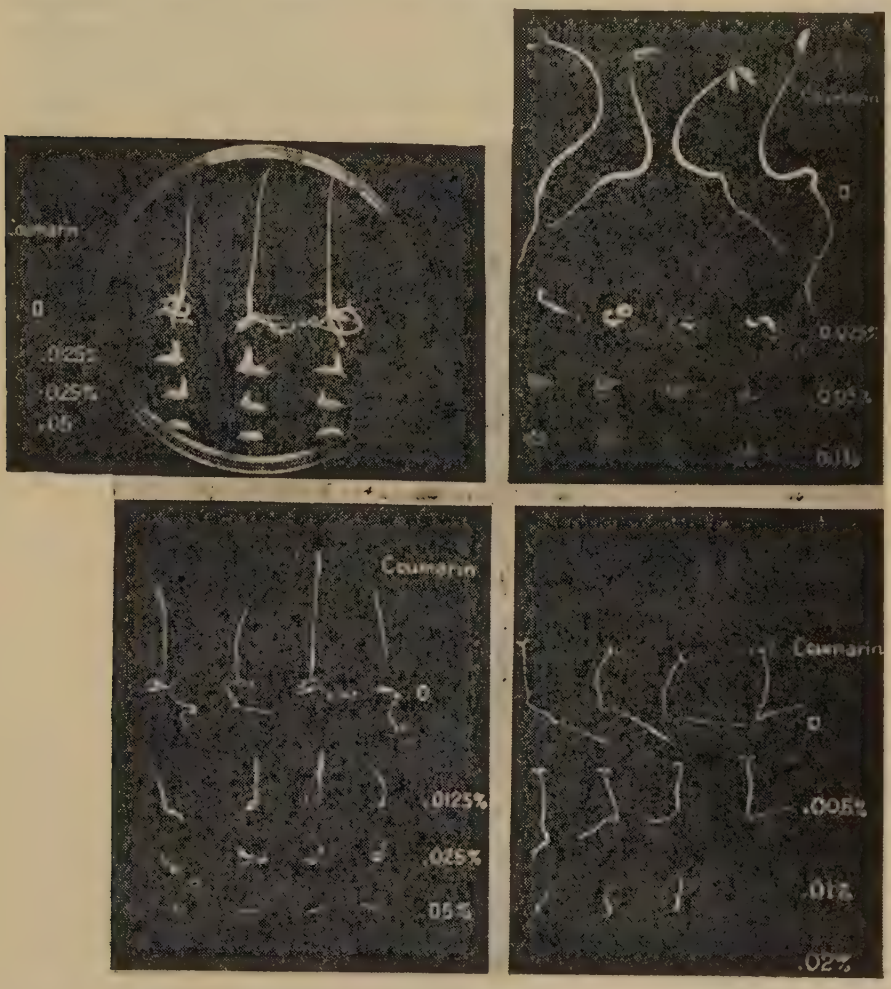

Fig. 12.—Upper panel, left—rice treated with coumarin, 5 days after seeding; right—*I. triloba* treated with coumarin, 4 days after seeding; lower panel—*E. crusgalli* treated with coumarin, 10 days after seeding; right—*A. spinosus* treated with coumarin, 5 days after seeding.

After six days in the Petri dishes, most of the exposed tissues of the treated seeds seemed to be undergoing decay, becoming slimy, brownish, and misshapen.

Plantings in the greenhouse showed that germinated seeds treated with 0.0125 per cent coumarin lived and produced visibly normal seedlings.

Effect on Ipomoea. Germination of Ipomoea was markedly inhibited especially in seeds treated with 0.1 and 0.05 per cent coumarin (fig. 13). For some time, no sign of the radicle was observed in these two treatments. Breaking of the seed coats due to swollen embryos exposed part of the wrinkled, yellowish cotyledons but not the radicle tips. Rarely were entire embryos out of their seed coats, and if out, the hypocotyls were exceedingly stunted (fig. 12, upper right). A gelatinous exudation was present around all the treated seeds that had ruptured coats. Decided delay in germination was shown by the fact that 36 hours after seeding, the control had 90 per cent germination while seeds in the first two treatments were just beginning to germinate. A greatly reduced percentage germination was observed among the treated seeds.

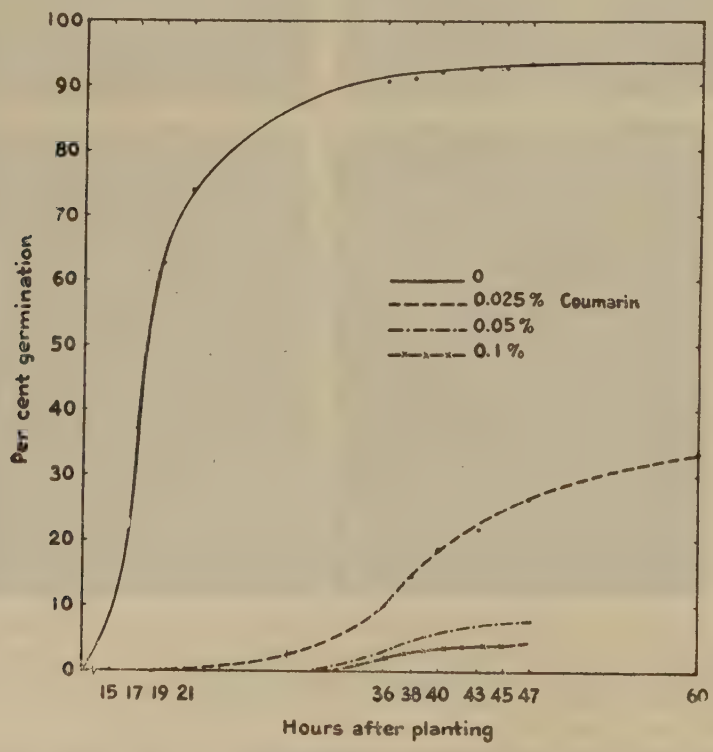

Fig. 13.—Effect of coumarin on percentage germination of *I. triloba* at various hours.

All plantings of germinated treated seeds in the greenhouse did not live.

Effect on Echinochloa. At 0.05 per cent, inhibition of Echinochloa was almost complete (fig. 14). Germination of the treated seeds was delayed about two to four days after that of the control. While 21 per cent of the seeds treated with 0.025 per cent coumarin were considered germinated, most plantings of them in the greenhouse were not successful. Two types of seedlings were obtained from this treatment, those with roots and those without, the latter constituting the majority. The seedlings with roots lived. They developed quite slowly but were otherwise as normal as those from the 0.0125 per cent treatment and the control.

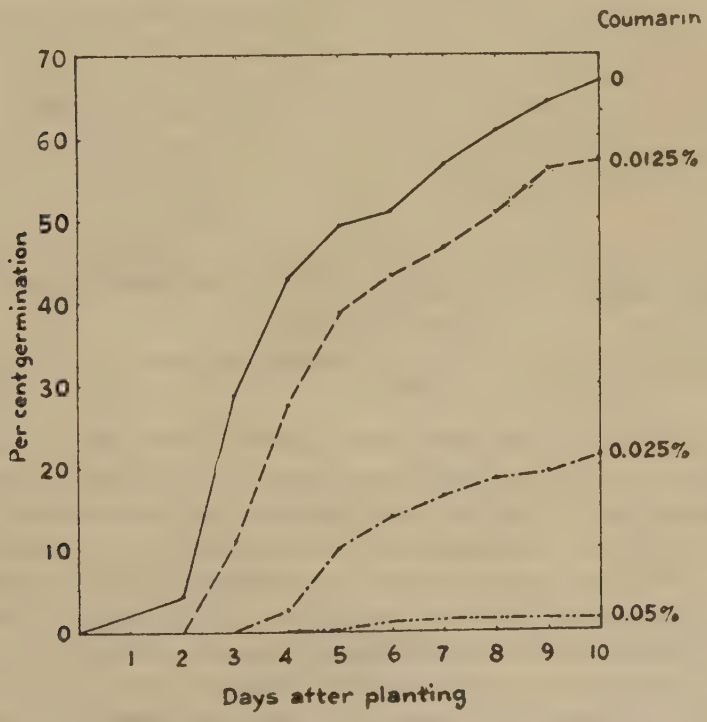

Fig. 14.—Effect of coumarin on percentage germination of *E. crusgalli* at various days.

Seedlings from seeds treated with 0.0125 per cent coumarin had conspicuously sturdier plumules (fig. 12, lower left). The leaves of the seedlings from the treated seeds were markedly broader and

darker green than those of the control, but the roots were decidedly stunted, averaging 1.3 cm. long against 4.8 cm. of the control.

Effect on Amaranthus. Almost complete inhibition of Amaranthus was obtained at 0.01 per cent. While maximum germination was obtained in the control 49 hours after seeding, no germination was obtained in seeds treated with 0.01 per cent until the 89th hour (fig. 15). Compared with the control, seedlings of the treated seeds were stunted (fig. 12, lower right). The hypocotyls one week after seeding gave the following averages: control—3.9 cm; treatment 0.0025 per cent—2 cm.; treatment 0.005 per cent—0.9 cm.

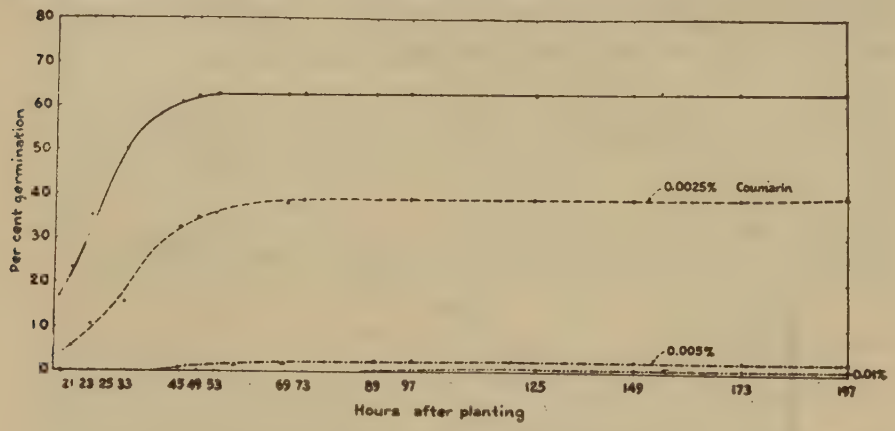

Fig. 15.—Effect of coumarin on percentage germination of *A. spinosus* at various hours.

The plantings in the greenhouse, except the control, all died.

Palay in the tests showed much greater sensitivity to coumarin than Echinochloa. This is partly explained by the observation of Nutile (1945) that coumarin is photosensitive after entering the seeds and will not exhibit effects on germination if the seeds are soaked in light or if light strikes the seeds while they are wet. It may be recalled that Echinochloa seeds were all grown in the greenhouse. There is no ready explanation, however, for the marked enlargement or apparent sturdiness of the plumules from the coumarin-treated Echinochloa seeds except perhaps that coumarin had a favorable effect on the seeds upon being denatured by the action of light.

The suppression of root growth was expected, for coumarin and coumarin derivatives are known to inhibit the growth of roots by

slowing down their metabolism and by blocking mitosis (Goodwin and Taves, 1950). While it is clear that the possibilities of coumarin as a selective herbicide in relation to rice are nil, use of it in seed storage or in inducing dormancy in seeds or other plant organs gives promise. The effects of coumarin on seed germination and on root growth have been shown to be reversible. It is regarded as an inhibitor rather than as a toxic substance. Experiments by Nutile (1945) have shown that the dormant condition of black-seeded Simpson lettuce brought on by coumarin can be overcome by exposing the seeds to high humidity and light. Coumarin can then again throw them back into dormancy.

Effects of CMU on germination

The concentrations used of CMU were much higher than those of any of the chemicals. All four kinds of seeds were tested with 2 per cent, 1 per cent, 0.5 per cent, and 0.25 per cent solutions. The experimental technique of the preceding experiments was adopted.

The previous statement that inhibition diminished with increasing dilution does not hold quite true for this inhibitor. Inhibition of root growth and change in polarity of the seedlings were evident.

Effect on palay. It will be noted that the first observation on the effect of palay was made 50 hours after seeding and that the

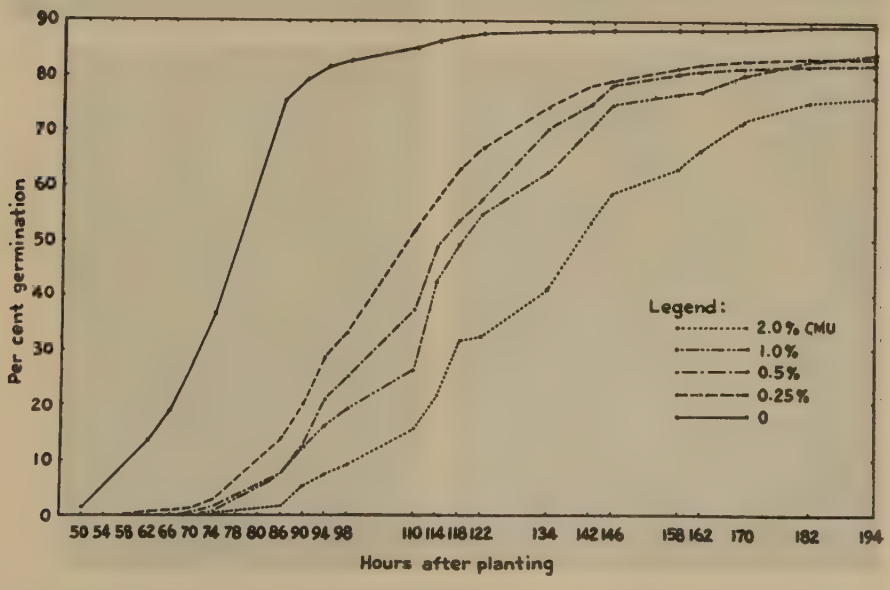

Fig. 16.—Effect of CMU on percentage germination of rice at various hours.

maximum percentage germination of the control was not as high as in previous experiments (fig. 16). This was the last of the series of experiments on palay, and the seeds while in storage must have lost part of their viability and vitality.

All treated seeds produced visibly normal shoots, but the radicles were hardly developed (fig. 17, upper left). At the two highest con-

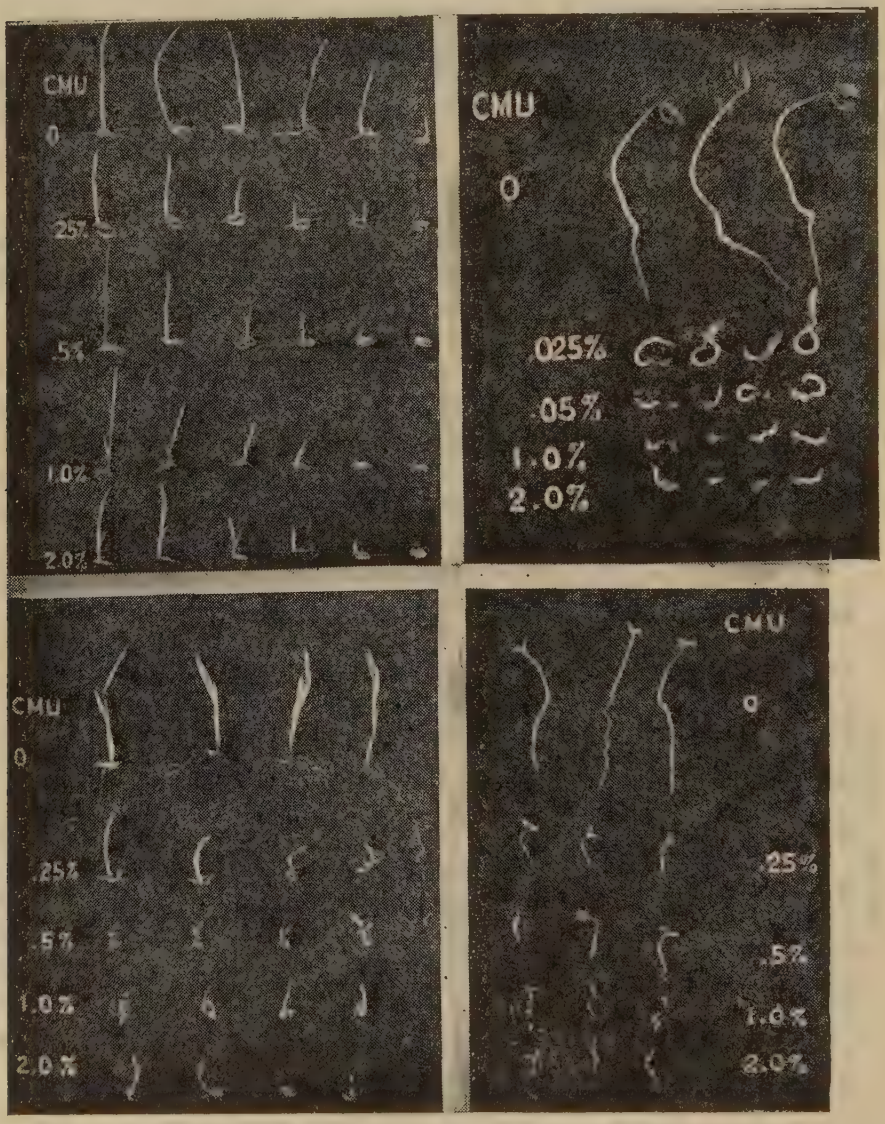

Fig. 17.—Upper panel, left—rice treated with CMU, 6 days after seeding; right—*I. triloba* treated with CMU, 2½ days after seeding; lower panel, left—*E. crusgalli* treated with CMU, 10 days after seeding; right—*A. spinosus* treated with CMU, 5 days after seeding.

centrations, the radicles that had succeeded to grow longer than the first appeared brownish and withered. Plumules were formed normally in all the treated lots but were slightly delayed in development.

The germinated treated seeds planted in the greenhouse seemed dead for some time, the shoots withering, but most of them revived after two weeks. Those that died never developed any root.

Effect on Ipomoea. The change in polarity was quite evident in Ipomoea, the germinated seeds tumbling in all directions on the moist filter paper and the hypocotyls forming all sorts of curves (fig. 17, upper right). There was a marked reduction in germination percentages among the treated seeds, but only a slight delay in the onset of germination (fig. 18). Tips of the radicles of the inhibited embryos appeared coated with a brownish corky layer, which was greater in extent among the embryos in the more concentrated

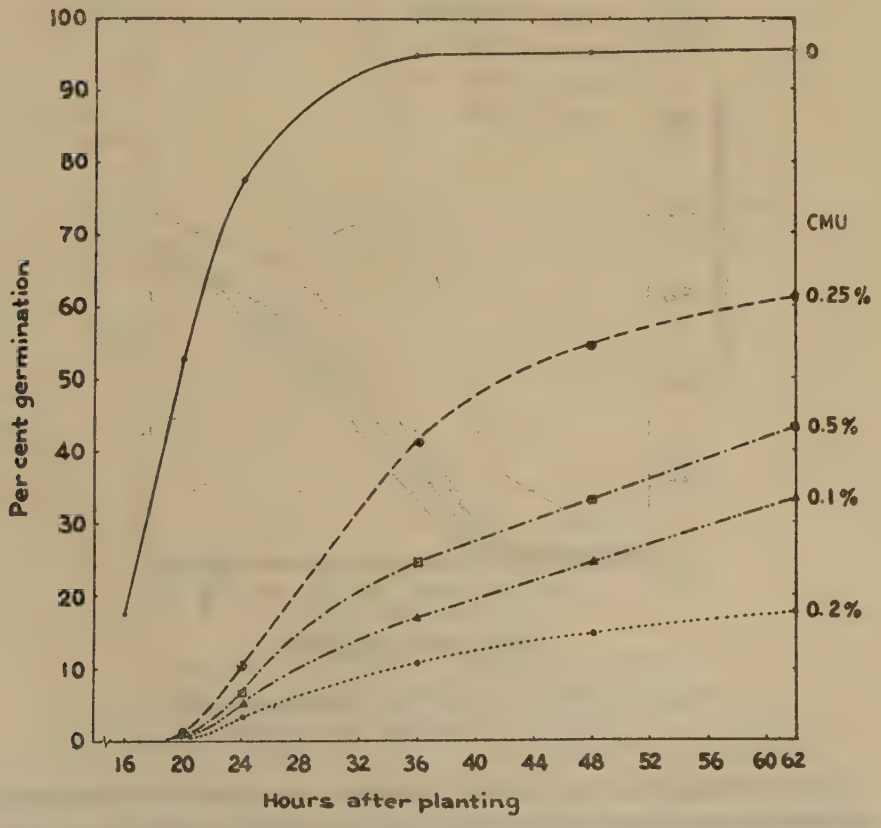

Fig. 18.—Effect of CMU on percentage germination of *I. triloba* at various hours.

solutions. Average hypocotyl lengths three days after seeding may be summarized as follows: control—7.2 cm.; 0.25 per cent—1.6 cm.; 0.5 per cent—1.2 cm.; 1 per cent—0.9 cm.; 2 per cent—0.7 cm.

For a time, all plantings made in the greenhouse seemed alive, but a week after, seedlings from the treated seeds died. At this time, the control had two true leaves which were fully expanded.

Effect on Echinochloa. Except in the 2 per cent treatment the onset of germination was not delayed, but percentage germination was reduced in the treated lots (fig. 19).

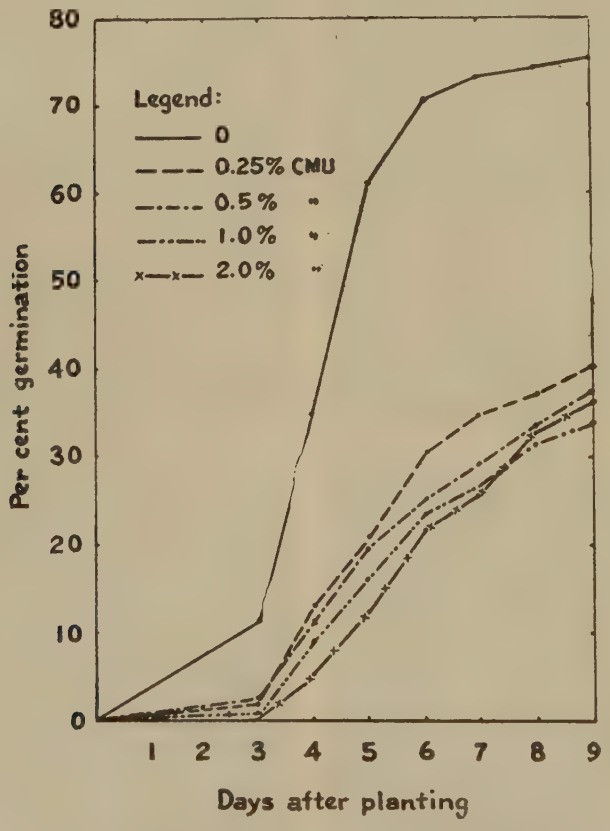

Fig. 19.—Effect of CMU on percentage germination of *E. crusgalli* at various days.

Root formation was totally inhibited, and while the plumules appeared normal, they were visibly narrower-leaved than the control (fig. 17, lower left).

Germinated treated seeds planted in the greenhouse remained green for a week, but after 11 days they died because of failure to produce roots.

Effect on Amaranthus. The inhibitor had a rather confused effect (fig. 17, lower right). Two per cent CMU produced a higher percentage of germination than 1 per cent, and 1 per cent higher than 0.5 per cent (fig. 20). There was, however, a gradient effect of the inhibitor on organ development with the various concentrations, as shown by the following average lengths of the hypocotyls taken five days after seeding: control—2.2 cm.; 0.25 per cent—0.64 cm.; 0.5 per cent—0.6 cm.; 1 per cent—0.5 cm.; 2 per cent—0.38 cm.

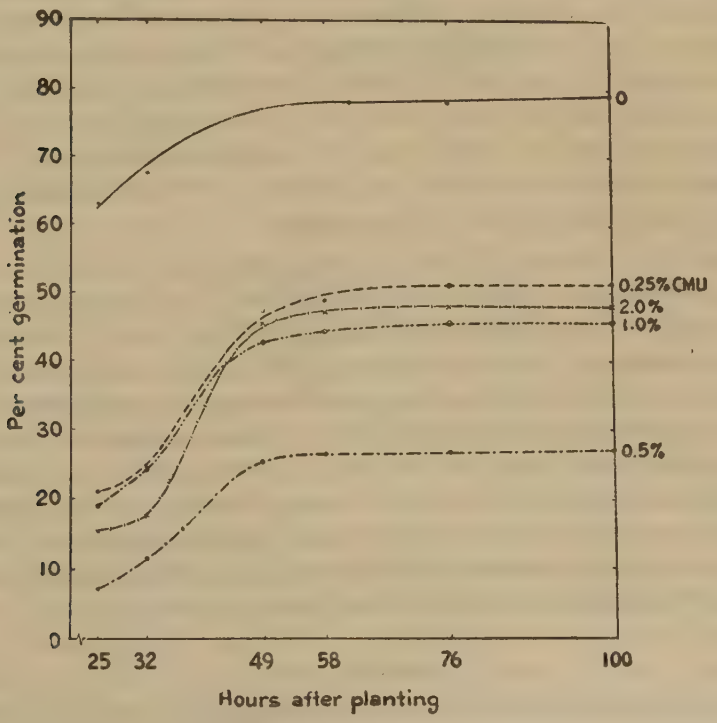

Fig. 20.—Effect of CMU on percentage germination of *A. spinosus* at various hours.

All treated seedlings planted in the greenhouse did not live.

That CMU is not a germination inhibitor but, rather, a straight-growth inhibitor is indicated in this study. Apparently, the chemical produces its more pronounced effects after the radicles and plumules

have emerged. Previous observations of Bucha and Todd (1951) suggest strongly that it acts readily through the root system and is translocated upward to the leaves. It is not a selective herbicide, for it destroys all vegetation and has been recommended for noncroplands such as railroad right of way.

Preliminary study of the mechanism of inhibition

Water absorption is an indispensable initial process in germination and is analogous to a trigger which starts the vital processes.

In order to determine the effect of maleic hydrazide on water absorption, parallel series of treated (0.4 per cent MH) and untreated seeds were run in six replications with 100 rice seeds each. Each sample was initially weighed and the amounts of water absorbed at various hours during a period of 30 hours were determined, using independent samples for each determination. At each determination the liquid in each Petri dish was drained and the liquid clinging to the seed was blotted up by absorbent tissue paper. Weighings were all done in an analytical balance. The percentage of water absorbed was based on the initial weight.

When the averages of the two treatments for each hour of sampling were treated by paired data comparison, the difference between the treatments was highly significant. There was a consistently lower percentage of water absorption in the seeds treated with maleic hydrazide (fig. 21). During the first 15 hours the differences were not very marked, but towards the end of the observation there was a big difference between the two curves. This leads to the speculation that the physical processes of water intake like diffusion and imbibition are not markedly affected by maleic hydrazide. It may rather be that the biochemically actuated process of water absorption (active absorption) is involved in this inhibition.

DISCUSSION

The few species studied showed a remarkable variation in their readiness to germinate. Rice, the only cultivated species in the group, had a high percentage of germination even right after harvest. With some exceptions, readiness to germinate is a general characteristic of cultivated species. The often-repeated explanation for this is that in the course of domesticating them man subconsciously selected the strains which would grow at his bidding or behave according to his desire.

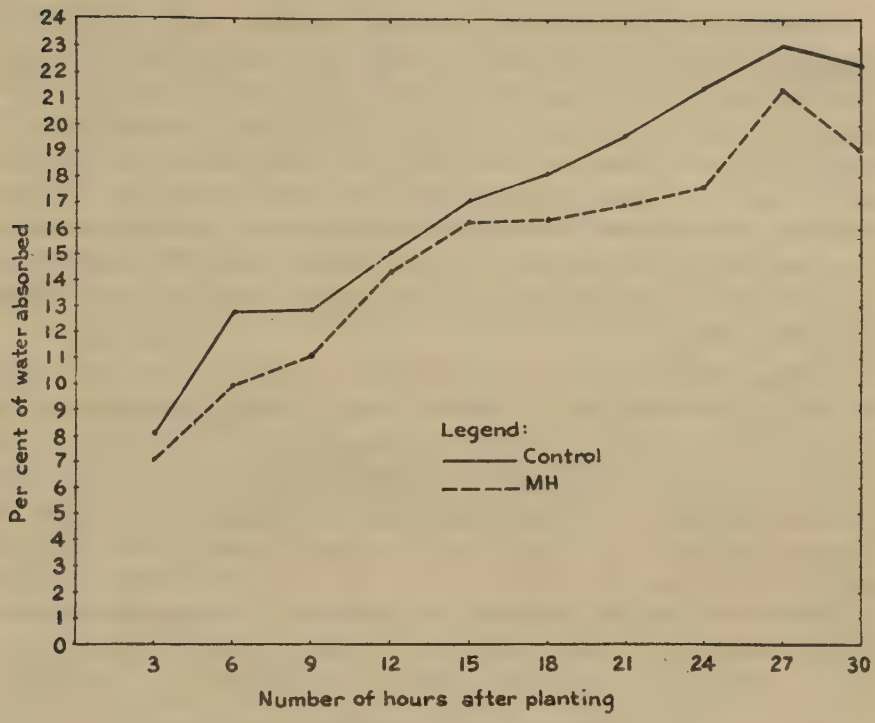

Fig. 21.—Effect of 0.4 per cent MH on water absorption of rice. Each point represents the mean of 6 replicates.

On the other hand, the three species of weeds studied showed varying degrees of dormancy. Echinochloa had a few seeds germinating soon after planting. Germination of the other seeds dragged on to the end of the observation. Ipomoea and Amaranthus would not germinate under the ordinary conditions for germination given them. Ipomoea had to be treated with sulfuric acid or scarified. Apparently, the main impediment to its germination was the hard, impermeable seed coat. Amaranthus responded best to stratification at low temperature. Certain chemical changes seemed to be requisites for germination. It is apparent that each species reacts individually to its environment.

Dormancy appears to have some survival value in nature. With it germination may be timed to occur with favorable weather so that survival of the young plant is insured. Dormancy may also serve to stagger germination so that the seeds will not germinate all at once. Then the occurrence of drastic conditions will not expose the species to extinction.

The species behaved in noticeably various ways towards the chemicals. While rice showed a marked delay and reduction in germination at 0.05 per cent MH, Echinochloa showed marked reduction even at 0.1 per cent. On the other hand, Amaranthus did not show much reduction at 0.1 per cent MH; neither did Ipomoea at 0.5 per cent. The herbicide 2,4-D was more severe on Ipomoea and Amaranthus than on rice and Echinochloa. The same observation may be said of coumarin. CMU seemed not to be selective on any particular species. It also dragged germination much longer than the control.

These observations point to differences among species in physiology of germination. It may be that different mechanisms are not involved; rather, that alternate mechanisms vary in their efficiency. For instance, it may be supposed that germination involves the reaction A → B → C → D and that an alternate mechanism occurs so that when the step B →C is blocked, germination can still proceed by taking the path A → B → X →D. The effect of a chemical like 2,4-D may be the same on all species, but species differ in their susceptibility to this herbicide because of the varying efficiency of the alternate mechanisms. This may be the basis of selectivity.

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COLLEGE AND ALUMNI NOTES

A big welcome mat was rolled out for Dean and Mrs. Leopoldo B Uichanco on their arrival September 21 from five and one-half months' travels in Europe and America.

Students and faculty officially greeted the couple at a convocation held on the 28th. The Dean related highlights of their experiences in Europe, where he represented the National Research Council of the Philippines in the UNESCO meeting of directors of national research centers at Milan, and in America, where he observed the fiscal policy and management of agricultural colleges and experiment stations.

The language barrier on the Continent, the Dean said, made them feel at home as soon as they got to the United States. But it was not until they reached Ithaca that they really felt at home, he added.

In Europe Dean Uichanco toured the FAO headquarters in Rome, the Jardin des Plantes in Paris, the laboratories of the Consejo Superior de Investigaciones Cientificas in Madrid, the Technische Hochschule in Zurich, the Kew Garden and the Rothamsted Experiment Station near London.

Reaching New York on May 5, he visited Columbia University, the New York Botanic Garden, Washington D.C., Beltsville and the University of Maryland, Harvard University, Cornell University, University of Florida, University of Puerto Rico, Agricultural Experiment Station and Extension Service at Rio Piedras, Isabela and Lajas substations, College of Agriculture, the Federal Experiment Station at Mayaguez, Purdue University, and University of California.

On their way home the couple stopped over in Honolulu and Japan.

Dean and Mrs. Uichanco left Manila on April 5. The Dean's travel in the United States was under the ICA program.

On September 28, a parade and review was held in the Dean's honor by the UP Los Baños ROTC Unit.

Rice and corn "know-how" drew a record attendance to the first field day of the school year on September 3.

Demonstrations in the Central Experiment Station field on pest, disease, and weed control, improved practices, fertilization, drainage and irrigation, variety improvement, baling, and ensiling occupied the morning. In the afternoon, after a talk by extension man Ernesto B. Rigor on the rice and corn seed program of the Philippines and another on fertilization by Mrs. Antonia de Silva, successful farmer of Santa Rosa, Laguna, the audience was invited to ask questions at an open forum. Members of the panel were agricultural specialists from the Bureau of Agricultural Extension, Bureau of Plant Industry, Irrigation Service Unit, ACCFA, and Araneta Institute of Agriculture.

Exhibits on rice and corn were on display at the Agronomy Building all day.

Intended to bring the findings of the laboratory straight to the farm folks, the Rice and Corn Field Day was a cooperative project between the different departments and the Bureau of Agricultural Extension. A central committee headed by Thomas G. Flores dovetailed the arrangements for the event.

Young blood represented the College at two FAO-sponsored international meetings. Pedro S. Castillo left August 31 to attend the 1955 Training Institute on Rice Breeding at the Central Rice Institute at Cuttack, India. Eusebio C. Inocencio enplaned September 14 for Colombo, Ceylon, to participate in the Technical Meeting and Training Center on Farm Mechanization and Workshop Problems.

Coffee and cacao seedlings from the Bureau of Plant Industry in Washington arrived by air September 6 for testing in the College and Central Experiment Station.

The 334 coffee seedlings were mostly of the widely grown arabica type with samples of the bourbon type, said to be the highest yielding coffee in the world. They will be tested for rust resistance at the Department of Plant Pathology before being turned over to the Department of Agronomy for breeding.

The 10 cacao seedlings were from United Fruit Company clones selected for high yield. They composed a trial shipment to find out how well cacao seedlings can stand long travel by air.

The seedlings originally came from Glendale, Maryland, and the Plant Introduction Garden in Coconut Grove, Florida, where plants are shipped to experiment stations all over the world.

Home from a year's work at Cornell University are PHILCUSA-FOA trainees Leopoldo S. Castillo (dairy manufacture), Jorge C. Davide (soil fertility and fertilizers), Gonzalo V. Garcia (beef production), Martin E. Raymundo (soil survey and classification), Basilio N. de los Reyes (prices and statistics), and Obdulia Fronda Sison (extension education).

Their PHILCUSA-ICA successors on the Ithaca campus are Lito R. Calo (forage crops and pasture management), Igmidio T. Corpuz (soil conservation), Rogelio R. Covar (instrumental analysis, spectography, and spectrophotometry), Emerita de Guzman (plant nutrition), Martin V. Jarmin (teacher education), Juan B. Sta. Maria (irrigation and drainage), and Agustin N. Pordesimo (fungicides and their methods of application).

Also PHILCUSA-ICA trainees but assigned to other schools are Teodoro G. Cadiz (vegetable improvement—Louisiana State College), Ricardo M. Lantican (plant breeding—North Carolina State College), and Pedro R. Sandoval (agricultural finance and land economics—University of Minnesota).

Amado C. Campos (poultry breeding) and Genaro O. Ranit (poultry nutrition) are Rockefeller Foundation fellows at Cornell University. Partial awards were given to Nona L. Calo for traveling expenses to and from Ohio State University where she is studying biochemistry and Salome del Rosario for advanced study on plant virus diseases at Kansas State Agricultural College.

Daniel K. Maramba is at Cornell University and Rogelio Samson at Michigan University for graduate engineering work.

All the US-bound scholars were honored at a mass despedida by their coworkers at the Seniors' Social Garden on the night of August 31.

Walfrido P. Novero lost his bachelor standing when he married Pilar B. Lazaro at the Calamba Catholic Church on September 18.

Speakers at the Agricultural Economics seminars in September were Mr. Prentice Julian on "Roads and Land Settlement," Dr. D. L. Umali on "Why Rice and Corn Breeding Is Important," Dr. Meredith Givens on "Population and Labor Force," and Mr. Clark Milligan on "A Crop and Livestock Reporting Program for the Philippines."

A slide lecture on "Prices and Seasons" by Andres D. Goseco was featured at the August 27th meeting of the Farm Economics Association of the Philippines.

The Land Economics class under Dr. H. von Oppenfeld observed the physical and economic factors accounting for land use in the barrios of Dayap, Wakat, and Manaol, Laguna, on August 26. The same class had Prof. M. G. Cline as guest lecturer on September 7 and 14. Prof. Cline showed slides of major US soil types and soil conditions in British Africa.

Drs. Nicolas L. Galvez and Lyle E. Nelson were in Legaspi, Tacloban, Cebu, Bacolod, and Davao from September 5 to 12 to locate and lay out fertilizer experiments on major crops with the help of the Bureau of Plant Industry and the Fertilizer Administration.

Archimedes Laurel, '55, is with the Manila office of the International Harvester Company.

Antonio Ordoveza, '55, is majoring in beef cattle in Kansas State College.

Teodoro L. Olmo, '41, of the Iloilo National Agricultural School left for the United States to study swine management.

Proud fathers at the Department of Agricultural Engineering are Burton T. Oñate, Juan B. Sta. Maria, and Remigio Rigor. The Oñates and the Rigors passed out cigars for their "firsts." The Sta. Marias got a girl this time.

Trinh Dúc Thong, special assistant to the Minister of Information of Vietnam, was on the campus September 28 to study the information work of the College.

Roem Purnariksha, '28, conferred with Dr. F. M. Fronda on the organization of experiment stations on September 29. He is now chief of the Research and Experiment Station Division, Department of Agriculture, Thailand.

THE PHILIPPINE AGRICULTURIST
(Formerly The Philippine Agriculturist and Forester)

Published by the COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
UNIVERSITY OF THE PHILIPPINES

SWORN STATEMENT

(Required by Act No. 2580)

The undersigned, business manager of THE PHILIPPINE AGRICULTURIST, published monthly, except April and May, in English at the College of Agriculture, College, Laguna, after having been duly sworn in accordance with law, hereby submits the following statement of ownership, management, circulation, etc., which is required by Act 2580, as amended by Commonwealth Act 201:

Editor: Dean L. B. Uichanco, College, Laguna, Philippines
Managing Editor: Dr. J. R. Velasco, College, Laguna
Business Manager: Dr. J. M. Capinpin, College, Laguna
Publisher: College of Agriculture and Central Experiment Station, University of the Philippines, College, Laguna, Philippines.

Owners or stockholders holding one per cent or more of total amount of stock: University of the Philippines, Diliman, Quezon City, Philippines.

Bondholders, mortgagees, or other security holders owning one per cent or more of total amount of securities: None.

Total number of copies printed and circulated, Sept. 30, 1955: 5,000.

(Sgd.) J. M. CAPINPIN
Business Manager

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Page No. 44
Book No. 111
Series of 1955.

(Sgd.) ISIDRO P. GUICO
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